Diazinon Criteria Derivation
DRAFT

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1. Introduction

An updated methodology for deriving freshwater water quality criteria for the protection of aquatic life was developed (TenBrook *et al.* 2009a). The need for a new methodology was identified by the California Central Valley Regional Water Quality Control Board (CVRWQCB 2006a) and findings from a review of existing methodologies (TenBrook & Tjeerdema 2006, TenBrook *et al.* 2009b). This new methodology is currently being used to derive criteria for several pesticides of concern in the Sacramento River watershed. The methodology report contains an introduction, (Chapter 1); the rationale of the selection of specific methods (Chapter 2); detailed procedure for criteria derivation (Chapter 3); and a chlorpyrifos criteria report (Chapter 4). This criteria report for diazinon describes, section by section, the procedures used. Also included are references to specific sections of the methodology procedure detailed in Chapter 3 of the report so that the reader can refer to the report for further details (TenBrook *et al.* 2009a).

2. Basic information

Chemical: Diazinon (Fig. 1)
CAS Number: 333-41-5
USEPA PC Code: 057801 (PAN 2006)
CA DPR Chem Code: 198 (PAN 2006)
CAS: O,O-diethyl O-[6-methyl-2-(1-methylethyl)-4-pyrimidinyl] phosphorothioate
IUPAC: O,O-diethyl O-2-isopropyl-6-methylpyrimidin-4-yl phosphorothioate

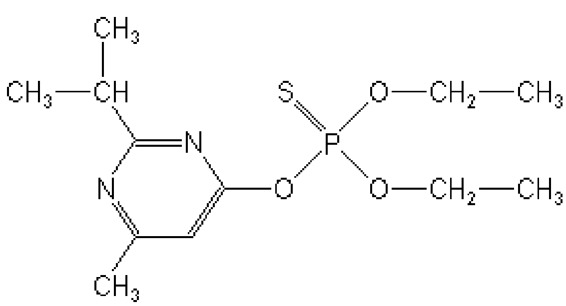

Figure 1. Structure of diazinon (Wood 2006).

Trade names: Alfa-Tox, AG-500, Basudin, Bazinon, Bazuden, Ciazinon, Dacutox, Dassitox, Dazzel, Desapon, Dianon, Diater, Diaterr-fos, Diazitol, Diazide, Diazol, Dicid, Dimpylate, Dipofene, Dizinon, Dyzol, ENT 19507, Flytrol, G 301, Gardentox, Geigy 24480, Kayazinon, Kayazol, Knox Out, NA 2763, Nedicisol, Neocidol, Nucidol, Sarolex, Spectracide, D-Z-N (Agrochemicals Handbook 1991; EXTOXNET 2007; Mackay *et al.* 1997).

3. Physical-chemical data

Molecular Weight
304.36 (Mackay *et al.* 1997)

Density
1.11 g/cm^3 at 20°C (Worthing 1991)
1.116-1.118 g/cm^3 at 20°C (Milne 1995; Montgomery 1993; Tomlin 2003)

Water Solubility
40 mg/L at room temperature (Martin & Worthing 1977)
40 mg/L at 23.5-26.0°C (Jarvinen & Tanner 1982)
40.5 mg/L at 20-22 °C (Kanazawa 1981)
68.8 mg/L at 22 °C (Bowman & Sans 1979; 1983b)
Geometric Mean: 46.0 mg/L

Melting Point
Liquid at room temperature (Tomlin 1994)

Vapor Pressure
8.2×10^{-5} mm Hg at 25°C (0.011 Pa, Kim *et al.* 1984)
1.5×10^{-4} mm Hg (0.02 Pa, Hinckley *et al.* 1990)
9×10^{-5} mm Hg (0.012 Pa, Tomlin 1994)
Geometric Mean: 1.0×10^{-4} mm Hg (0.014 Pa)

Henry's constant (K_H)
0.011 Pa m^3/mol = 4.6×10^{-6} dimensionless (wetted-wall column, Fendinger & Glotfelty 1988)
0.0119 Pa m^3/mol = 4.8×10^{-6} dimensionless (mean of two values from fog chamber method, Fendinger *et al.* 1989)
Geometric Mean: 0.0114 Pa m^3/mol = 4.7×10^{-6} dimensionless

Organic carbon-water (K_{oc}) or organic matter-water (K_{om}) partition coefficients
132 (K_{om}, Briggs 1981)
250 (K_{om}, Sharom *et al.* 1980)
2049, 2247, 2087 (K_{oc} in natural soil, TOC = 3.8-4.3 g/kg, Iglesias-Jimenez *et al.* 1997)
5810, 5718, 6777 (K_{oc} in natural soil amended with humic acid, TOC = 13.6-15.4 g/kg, Iglesias-Jimenez *et al.* 1997)
348 (K_{om}, mean of 25 soils, Arienzo *et al.* 1994)

840 (K_{oc}, mean of 5 soils converted from K_d values using % organic carbon data, Cooke *et al.* 2004)
251 (K_{oc}; mean of 2 soils; Kanazawa 1989)
Mean (weighted) K_{om}: 336
Mean (weighted) K_{oc}: 2261

Log K_{ow}
3.79 (Tsuda *et al.* 1997a)
3.81 (Bowman & Sans 1983a)
Use: 3.81 (recommended by Sangster Research Laboratories 2004)

pK_a
2.4 (Ku *et al.* 1998)

Environmental Fate

Table 1. Diazinon hydrolysis and photolysis.

	Half-life (d)	Water	Temp (°C)	pH	Reference
Hydrolysis	0.49	Buffer	20	3.1	Gomaa *et al.* (1969), Faust & Gomaa (1972)
	6	Buffer	20	10.4	Gomaa *et al.* (1969), Faust & Gomaa (1972)
	17	Milli-Q	40	8.0	Noblet *et al.* (1996)
	30	Lake Superior	22.5	7.4-7.8	Jarvinen & Tanner (1982)
	31	Buffer	20	5.0	Gomaa *et al.* (1969), Faust & Gomaa (1972)
	37.2	Filtered river	NR	NR	Medina *et al.* (1999)
	52	Filtered river	22	7.3	Lartiges & Garrigues (1995)
	69	Milli-Q	22	6.1	Lartiges & Garrigues (1995)
	80	River	22	7.3	Lartiges & Garrigues (1995)
	88	Milli-Q	24	8.0	Noblet *et al.* (1996)
	136	Buffer	20	9.0	Gomaa *et al.* (1969), Faust & Gomaa (1972)
	171	Distilled	21	7.3	Mansour *et al.* (1999)
	185	Buffer	20	7.4	Gomaa *et al.* (1969), Faust & Gomaa (1972)
Aqueous photolysis	12	0 mg/L humic material	25	NR	Kamiya & Kameyama (1998)
	9-12	5 mg/L humic material	25	NR	Kamiya & Kameyama (1998)
Photolysis plus hydrolysis	31.1	Filtered river	26-35	NR	Medina *et al.* (1999)

Bioconcentration Factor

Table 2. Bioconcentration factors (BCF) for diazinon. FT: flow-through; SR: static-renewal; S: static; values are on a wet weight basis and are not lipid normalized unless noted.

Species	BCF	Exposure	Reference
Carassius aurapus	37	FT (steady-state)	Tsuda *et al*. (1997b)
Cipangopoludina malleata	5.9	FT	Kanazawa (1978)
Cyprinus auratus	37	FT	Kanazawa (1978)
Cyprinus carpio	65	FT	Kanazawa (1978)
Cyprinus carpio (gallbladder)	39	FT (steady-state)	Tsuda *et al*. (1990)
Cyprinus carpio (kidney)	131	FT (steady-state)	Tsuda *et al*. (1990)
Cyprinus carpio (liver)	60	FT (steady-state)	Tsuda *et al*. (1990)
Cyprinus carpio (muscle)	25	FT (steady-state)	Tsuda *et al*. (1990)
Gnathopogon caerulescens	248	FT (steady-state)	Tsuda *et al*. (1989)
Indoplanorbis esustus	17	FT	Kanazawa (1978)
Labistes reticulates	17	FT	Kanazawa (1978)
Lebistes reticulates (females)	86	FT (steady-state)	Tsuda *et al*. (1997b)
Lebistes reticulates (males)	132	FT (steady-state)	Tsuda *et al*. (1997b)
Oryzias latipes	88	FT (steady-state)	Tsuda *et al*. (1997b)
Oryzias latipes	49	FT (steady-state)	Tsuda *et al*. (1997b)
Oryzias latipes	28	FT (steady-state)	Tsuda *et al*. (1995a)
Oryzias latipes	22	FT (steady-state)	Tsuda *et al*. (1995a)
Oryzias latipes	58	FT (steady-state)	Tsuda *et al*. (1995b)
Poecilia reticulata	224[a]	SR	Deneer *et al*. (1999)
Poecilia reticulata	148[a]	SR	Deneer *et al*. (1999)
Poecilia reticulata	188	SR (steady-state)	Keizer *et al*. (1993)
Poecilia reticulata	39	SR (steady-state)	Keizer *et al*. (1991)
Poecilia reticulata	46	SR (rate constant ratio)	Keizer *et al*. (1991)
Poecilia reticulata	59	SR (steady-state)	Keizer *et al*. (1991)
Poecilia reticulata	56	SR (rate constant ratio)	Keizer *et al*. (1991)
Procambarus clarkii	4.9	FT	Kanazawa (1978)
Pseudorasbora parva	152	FT (steady-state)	Kanazawa (1978; 1981)
Sarotherodon galilaeus	39	S	El Arab *et al*. (1990)
Tanichthys albonubes	36	FT (steady-state)	Tsuda *et al*. (1997b)

[a]Calculated from measured K_{ow} value and lipid content of fish

4. Human and wildlife dietary values

There are no tolerance or FDA action levels for fish tissue (USFDA 2000).

Wildlife LC_{50}s (dietary) for animals with significant food sources in water

Subacute dietary LC_{50} (lethal concentration for 50% of organisms tested) values range from 32-3912 mg/kg feed for mallard duck (USEPA 2004). An acute single dose LC_{50} for mallard by oral intubation was 1.44 mg/kg body weight (USEPA 2004). Another single dose (by oral gavage) LC_{50} for mallard duck was reported as 3.54 mg/kg body weight (Hudson *et al.* 1984).

Wildlife dietary NOECs for animals with significant food sources in water

The only dietary no observed effect concentration (NOEC) for diazinon is 8.3 mg/kg feed for mallard duck reproduction (USEPA 2004). This was from a chronic study in which diazinon was added to the breeding bird's diet throughout the breeding cycle.

USEPA (2004) also states that "Among pesticides, diazinon is the cause of the second most documented avian mortality incidents," but little information is available in this regard. Water may not be the route of exposure in these incidents.

5. Ecotoxicity data

Approximately 250 original studies on the effects of diazinon on aquatic life were identified. Single-species effects studies that were rated relevant (R) or less relevant (L) for relevance (see section 3-2.2, TenBrook *et al.* 2009a) were summarized in data summary sheets. Copies of completed summaries for all studies rated reliable and relevant (RR) for criteria derivation are included in Appendix C of this report. Information in these summaries was used to evaluate each study for reliability using the rating systems described in the methodology (section 3-2.2, TenBrook *et al.* 2009a). Diazinon studies deemed irrelevant from an initial screening were not summarized (e.g. studies involving *in vitro* exposures). All ecotoxicity data considered for criteria derivation are summarized in data tables at the end of this report.

Studies conducted according to methods described by the World Health Organization (WHO 1963) were not given credit for use of an acceptable standard method. The WHO method is unacceptable by more recent standards due to such things as allowing use of deionized water as a dilution water, using 4^{th} instar larvae (ASTM 2005 and USEPA 2000 require 2^{nd}-3^{rd} instars) and allowance of use of as much as 1 mL of carrier solvent per 100 mL test solution (various ASTM methods allow only 0.1 mL/L and 0.5 mL/L for chronic and acute tests, respectively).

Using the data evaluation criteria, 22 acute studies yielding 35 toxicity values were judged reliable and relevant for criteria derivation (Tables 3 and 4). Forty-two studies were rated RL, LL, or LR, where L = less relevant or less reliable, and may be used as supplemental information for evaluation of derived criteria (Table 8).

Thirty-three mesocosm, microcosm and ecosystem (field and laboratory) studies were found and are reviewed in section 14. Most of these studies used formulations or mixtures of several pesticides, rather than a technical grade or higher of diazinon alone. Also, for many of them, diazinon levels were not measured, and other water quality parameters were not reported. Four of these studies were rated R or L and may be used as supporting data. Ten more field studies that did not rate highly (because of the likely presence of other contaminants) were summarized in Appendix A. They were included because they focus mainly on toxicity in waterways in the California Central Valley. Other ecosystem-level studies were not summarized in summary sheets due to their complexity.

Wildlife values were found in USEPA (2004) and in Hudson *et al.* (1984). No data were used with the USEPA ACE program (v. 2.0; USEPA 2003) to estimate chronic toxicity values (to enhance the chronic data set) because there was sufficient experimental data to derive an ACR.

6. Data reduction

Multiple toxicity values for diazinon for the same species were reduced to one species mean acute value according to procedures described in the methodology (section 3-2.4, TenBrook *et al.* 2009a). Acceptable data that were excluded, and the reasons for their exclusion, are shown in Tables 4 and 6. The final acute and chronic data sets are shown in Tables 3 and 5, respectively. The final acute data set contains 13 species mean acute values; the final chronic set contains five species mean chronic values.

7. Acute criterion calculation

At least five acceptable acute toxicity values were available and fulfilled the five taxa requirements of the species sensitivity distribution (SSD) procedure (section 3-3.1, TenBrook *et al.* 2009a). There were eight or more toxicity values, so the Burr Type III SSD procedure was used to derive 5th percentile values (median and 95% confidence limit), as well as 1st percentile values (median and 95% confidence limit), as described in methodology (section 3-3.2.1, TenBrook *et al.* 2009a). Comparing the 95% confidence limit to the acute criteria, it can be seen that there is uncertainty in the first significant figure, thus the final criterion will be reported with one significant digit.

Fit parameters: alpha=2.139263; beta=0.328644. (likelihood=87.404858)

5th percentile, 50% confidence limit: 0.358949 μg/L
5th percentile, 95% confidence limit: 0.167165 μg/L
1st percentile, 50% confidence limit: 0.097011 μg/L
1st percentile, 95% confidence limit: 0.046147 μg/L

Recommended acute value = 0.3561 µ/L (median 5th percentile value)

Acute criterion = acute value ÷ 2 = 0.1781 µg/L
Acute criterion = 0.2 µg/L

Acute values were plotted in a histogram (Figure 2). The fit of the Reciprocal Weibull distribution from the BurrliOZ software is shown in Figure 3. The data appears to be bimodal with invertebrates encompassing the lower subset and fish and one amphibian in the upper subset. However, no significant lack of fit was found ($p = 0.18$) using a fit test based on cross validation and Fisher's combined test (section 3-3.2.4, TenBrook *et al.* 2009a), indicating that the whole data set should be used for criteria derivation. It is preferable to use as much data as possible to characterize the distribution; therefore the acute criterion was derived using the whole data set.

Alternative Approach: Bimodal distribution

Visual inspection of the distribution of acute toxicity values for diazinon indicated a bimodal distribution (Figure 2 and 3). The 13 species mean acute values were split into two groups. The six fish and snail species were relatively insensitive and the other seven invertebrates were relatively more sensitive. The more sensitive subset contained at least five species mean acute toxicity values; therefore, the SSD procedure was done with this lower subset. Since this data set had eight or fewer values the log-logistic distribution was used (section 3-3.2.2, TenBrook *et al.* 2009a). This distribution is plotted with the acute values in Figure 4.

For the sensitive subset of invertebrates, excluding mollusks:

<u>Log-logistic (ETX 1.3 Software)</u>
5th percentile, 50% confidence limit: 0.208136 µg/L
5th percentile, 95% confidence limit: 0.015287 µg/L
1st percentile, 50% confidence limit: 0.049358 µg/L
1st percentile, 95% confidence limit: results not available

Recommended acute value = 0.208 µg/L (median 5th percentile value)

Acute criterion = acute value ÷ 2 = 0.104 µg/L
Acute criterion = 0.1 µg/L

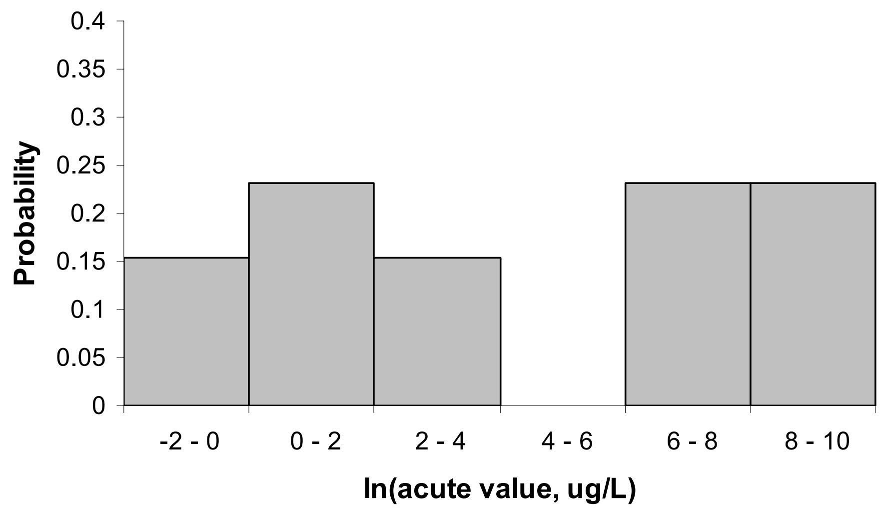

Figure 2. The natural log of the diazinon species mean acute values were plotted on a histogram to show the general shape of the distribution of the data. Data are split into two groups.

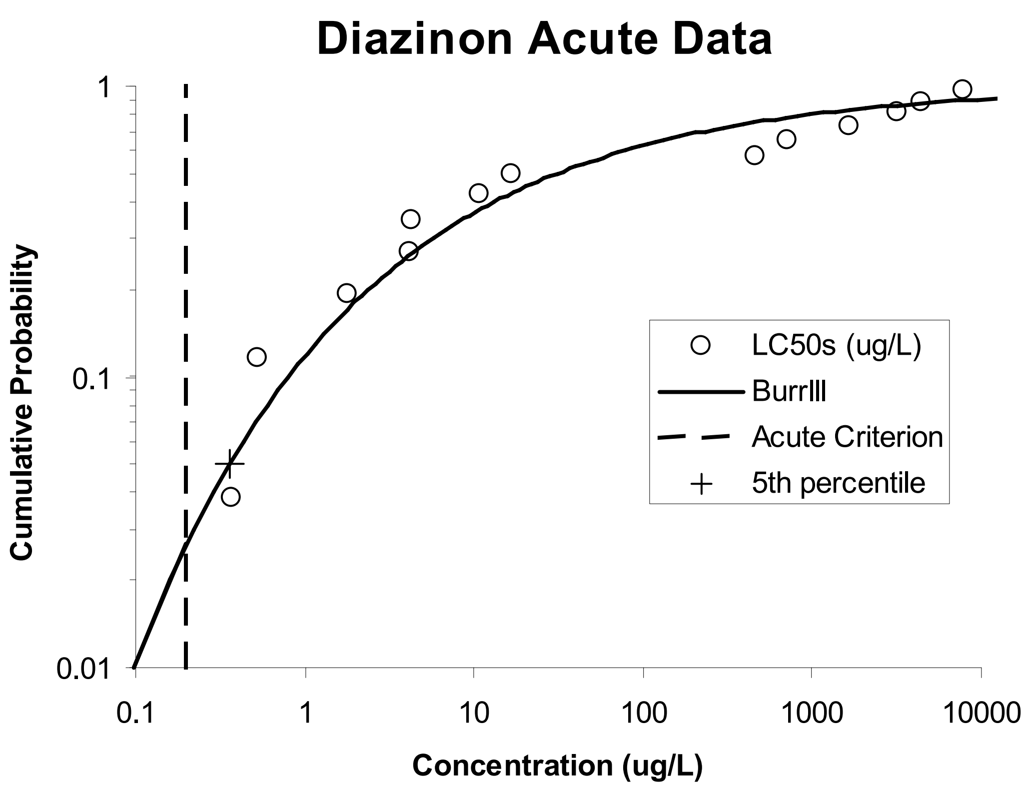

Figure 3. Plot of species mean acute values for diazinon and fit of the Reciprocal Weibull distribution. Graph shows the 5th percentile at 0.36 µg/L and the acute criterion at 0.2 µg/L.

Also included for comparison is the fit to the Burr Type III distribution. Using the BurrliOZ (v. 1.0.13; CSIRO 2001) program the data set fit a data points fit a Reciprocal Pareto distribution (i.e., the limiting Burr Type III distribution when the *c* parameter is > 80).

<u>Reciprocal Pareto distribution (BurrliOZ Software)</u>
Reciprocal Pareto: x0=16.820000; theta=0.548812. (likelihood=18.203151)

5th percentile, 50% confidence limit: 0.071647
5th percentile, 95% confidence limit: 0.015552
1st percentile, 50% confidence limit: 0.003816
1st percentile, 95% confidence limit: 0.000534

Example acute criterion = acute value ÷ 2 = 0.035 µg/L

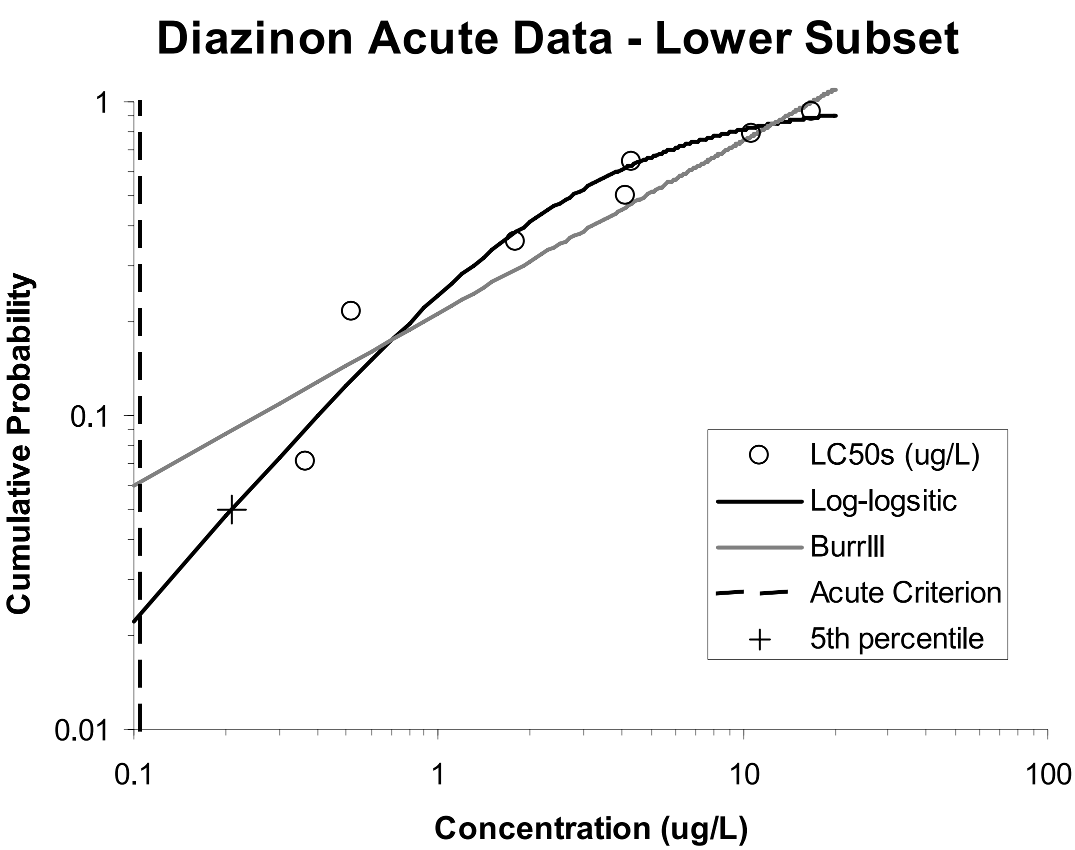

Figure 4. Plot of lower subset of species mean acute values and fit of log-logistic and Reciprocal Pareto distribution. Graph shows the 5th percentile at 0.21 µg/L and the acute criterion at 0.1 µg/L, calculated from the log-logistic distribution.

8. Chronic criterion calculation

Chronic toxicity values from fewer than five different families were available, thus the acute-to-chronic ratio (ACR) method was used. Eight chronic values are in the accepted (RR) data set (Table 5). There are three corresponding acute values for these chronic values. To avoid excessive layers of estimation, estimated chronic values were not derived to aid in calculating ACRs or to construct a chronic SSD.

Data used to calculate the ACR are shown in Table 7. There are three chronic data with corresponding acute values from at least three different families, so the ACR was calculated with the available data. There is a trend of increasing species mean ACR as the species mean acute values increase. The species with an acute value closest to the calculated 5th percentile acute value is *Daphnia magna*, ACR = 2.3. None of the other species ACRs are within a factor of 10 of that value; therefore the final ACR is 2.3 (section 3-4.2.1, TenBrook *et al.* 2009a).

Using the acute value calculated from the whole data set and the median estimate:
5th percentile, 50% confidence limit: 0.358949 μg/L
Chronic criterion = acute 5th centile value ÷ ACR = 0. 3561 μg/L ÷ (2.3) = 0.1548 μg/L
Chronic criterion = 0.2 μg/L

Using the acute value calculated from the whole data set and the lower 95th confidence interval of the estimate:
5th percentile, 95% confidence limit: 0.167165 μg/L
Chronic criterion = acute 5th centile value ÷ ACR = 0. 1672 μg/L ÷ (2.3) = 0.0836 μg/L
Chronic criterion = 0.1 μg/L

Using the acute value calculated from the more sensitive subset (log-logistic distribution):
5th percentile, 50% confidence limit: 0.208136 μg/L
Chronic criterion = acute 5th centile value ÷ ACR = 0. 2084 μg/L ÷ (2.3) = 0.0906 μg/L
Chronic criterion = 0.1 μg/L

9. Bioavailability

Few studies were found on bioavailability of diazinon, with even fewer pertaining to bioavailability to organisms in the water column. The bioavailability of diazinon to *Daphnia magna* was reduced in a liner relationship with increased dissolved humic material; presumably because diazinon was binding to the dissolved humic material (Steinberg *et al.* 1993.) Without more information is difficult to determine if the bioavailability of diazinon is predictable without site-specific, species-specific data. Until such data are available, compliance with criteria should be determined on a total concentration basis.

10. Mixtures

Diazinon often occurs in the environment with other organophosphate pesticides (TenBrook & Tjeerdema 2006). Since compounds in this class have a similar mode of action, either the toxic unit or the relative potency factor approach can be used to determine compliance in cases where organophosphate mixtures are present (section 3-5.2.1, TenBrook *et al.* 2009a).

Diazinon toxicity was synergized by cyanazine (Lydy & Austin 2004) and atrazine (Anderson & Lydy 2002, Belden & Lydy 2000). Table 9 shows the synergistic ratios (SR) for these studies, as well as for the interaction of diazinon with ammonia. The SR is obtained by dividing the EC_{50} for the pesticide alone by the EC_{50} in the presence of a non-toxic concentration of the synergist. Thus the SR reported in these studies is equivalent to the interaction coefficient (K). SR values > 1 indicate synergistic interaction; SR values < 1 indicate antagonistic interaction.

Since multiple K values are available for atrazine over a range of concentrations, these values were used to derive a quantitative relationship. Least squares regressions of the *Chironomus tentans* and *Hyalella azteca* combined data resulted in a significant relationship between atrazine concentration and K values ($p < 0.001$; JMP IN v.5.1.2; JMP 2004):

$$K = 0.0095(\text{Conc. Atrazine}) + 1.05 \quad (r^2 = 0.87,\ p = 0.0007) \qquad (2)$$

To determine compliance, or to assess potential for harm, equation 3 may be used to establish the effective concentration of diazinon in the presence of atrazine:

$$C_a = C_m(K) \qquad (3)$$

where:

C_a = adjusted, or effective, concentration of chemical
C_m = concentration measured
K = coefficient of interaction, calculated for the synergist concentration in water

The effective concentration may be compared to diazinon criteria, or may be used in one of the additivity models.

Less than additive (antagonistic) effects have been reported for the interaction of diazinon with copper and zinc (Banks *et al.* 2003, Van Der Geest *et al.* 2000b, Mahar & Watzin 2005), but data were not given that could be used to calculate interaction coefficients. Bailey *et al.* (2001) reported less than additive effects when *Ceriodaphnia dubia* were exposed to mixtures of ammonia and diazinon. The reduction in diazinon toxicity was moderate (K = 0.94) and was only calculable for a single ammonia concentration. Not enough data are available from these to allow derivation of a quantitative relationship between K values and antagonist concentration.

Ankley & Collyard (1995) reported reduced toxicity of diazinon to *Hyalella azteca* and *Chironomus tentans* in the presence of piperonyl butoxide (PBO), but antagonistic ratios were not reported. PBO is commonly used in toxicity identification evaluations because it is known to reduce the toxic effects of organophosphates (Ankley *et al.* 1991, Hunt *et al.* 2003). Since no interaction coefficients have been derived to describe antagonism between diazinon and piperonyl butoxide, it is not possible to quantify this non-additive toxicity. Consequently, there is no way to account for this interaction in compliance determination.

Organophosphate insecticides, such as diazinon, are increasingly used in combination with pyrethroids because they can synergistically increase the effects of pyrethroids, especially where pest populations have developed resistance (Perry *et al.* 2007). Denton *et al.* (2003) demonstrated that exposure to the pyrethroid esfenvalerate and diazinon resulted in greater than additive toxicity in fathead minnow larvae. These greater than additive effects were attributed to the complementary modes of toxic action of these two insecticide classes, which act on different components of nerve impulse transmission. Again, there is insufficient data to account for this interaction for compliance determination.

Interpretation of monitoring data in cases where synergists and antagonists are both present is not possible with the available models. If, for example, ammonia and a pyrethroid were both present in combination with diazinon, there would be no simple way to determine an effective concentration of diazinon that accounts for both interactions.

11. Temperature, pH, and other water quality effects

One study showed increased diazinon toxicity with increased temperature to *Chironomus riparius* (Landrum *et al.* 1999). However, this study was not rated RR, so it could not be used to quantify effects of temperature on diazinon toxicity. This study also investigated the effect of pH and found no clear correlation to toxicity. Among diazinon studies rated RR, there are no cases of chronic tests conducted at different temperatures with the same species. Three studies on *Chironomus tentans* sensitivity to diazinon at 20, 21 and 23 ^{o}C resulted in acute LC_{50} values of 30, 19.1, 10.7 μg/L, respectively (Ankley & Collyard 1995, Belden & Lydy 2000, Lydy & Austin 2004). However, important parameters such as life stage and nominal versus measured concentrations differed and could account for the differences in toxicity values. Data on other organophosphates show increased toxicity with increased temperature and no effect of pH in a variety of aquatic species (Lydy *et al.* 1999, Lydy *et al.* 1990, Baer *et al.* 2002, Patra *et al.* 2007).

Although there is evidence of temperature effects on diazinon toxicity, there is not enough data to adequately quantify the relationship at this time. Therefore, only results of tests conducted at standard temperatures are included in the data set and temperature equations are not needed for criteria expression.

12. Sensitive species

The calculated acute and chronic criteria (both 0.2 μg/L) are below all of the acute values in the data set. The lowest value in the acute data set is one of the values for *Ceriodaphnia dubia*, 0.21 μg/L, is similar to the criterion (Table 4). This value for *Ceriodaphnia dubia* is the lowest compared to eight others (0.32, 0.33, 0.33, 0.35, 0.38, 0.44, 0.47, 0.51, species mean acute value is 0.36 μg/L). Studies rated RL, LR, or LL also contain two values from one study for *Daphnia magna* approximately equivalent to the acute criterion, 0.20 and 0.22 μg/L (Sánchez *et al.* 2000, Table 8), but there are many more, well above the criterion, including the one that rated RR (0.52 μg/L).

The lowest measured chronic value in the data set rated RR is a maximum acceptable toxicant concentration (MATC) of 0.23 μg/L for *Daphnia magna* (Surprenant 1988a), which is just above the chronic criterion (0.2 μg/L). This is the only highly rated value for *Daphnia magna.* The supplemental data set (Table 8) contains six MATC values for *D. magna* that are approximately equivalent to the criterion (0.16, 0.16, 0.22, 0.24, 0.24 μg/L; from Dortland 1980, Fernández Casalderrey *et al.* 1995, Sánchez *et al.* 1998) and eleven MATC values for *Daphnia magna* that are below the chronic criterion, at 0.07 μg/L (Sánchez *et al.* 2000). These studies did not rate highly because they were not documented well. Another problem was that the authors reported the concentrations incorrectly in the report as ng/L instead of μg/L, which was checked via correspondence with the authors. This was a multi-generational test, which would be expected to be more sensitive than the test that only monitored reproduction in one generation (Surprenant 1988a). The only other chronic value for a Cladoceran is 0.34 μg/L for a *Ceriodaphnia dubia* 7-day test (Norberg King 1987), in the supplemental data set. *C. dubia* is the most sensitive species in the acute distribution; thus this gap in the chronic data may lead to underprotective criteria. The supplemental data set also contains a toxicity value of 0.13 μg/L for *Hyalella azteca*, which is below the chronic criterion, but the endpoint in this study does not have an established connection to survival, growth, or reproduction.

Chronic data is generally lacking for Cladocerans, the most sensitive taxon. There is one chronic toxicity value that was highly rated, and it is just above the chronic criterion, while other supplemental values are lower. There is very little data to show that the supplemental data are in error and no major problems were found with those studies, aside from incorrect units and missing documentation of some parameters. Therefore, the chronic criterion, as calculated may be underprotective of Cladocerans and use of one of the lower values for calculating the chronic criterion is recommended. Use of the result from either the lower confidence limit from the estimation using the whole data set or the median estimate using the lower subset would give a chronic value of 0.1 μg/L (section 8).

13. Bioaccumulation

Diazinon has a log K_{ow} of 3.81 (Sangster Research Laboratories 2004), and molecular weight of 304.3, which indicates its bioaccumulative potential. There are no tolerance or FDA action levels for fish tissue (USFDA 2000). Bioaccumulation of diazinon has been measured in a number of studies (Table 2). Palacio *et al.* (2002) found that juvenile tilapia exposed to a concentration of diazinon 10-fold lower than the determined 96-h LC_{50} (3.85 mg/L) reached steady-state accumulation (28.45 mg/kg) after 7.7 days, and that after six days in clean water, levels decreased to 0.29 mg/kg. Sancho *et al.* (1993) estimated a biological half-life of 25 and 26 hours for diazinon in the liver and muscle, respectively, of the freshwater eel, *Anguilla anguilla*. This study also observed elimination of diazinon once the animals were placed in clean water (over 50% eliminated after 24 hours).

El Arab *et al.* (1990) studied the bioaccumulation and excretion of ^{14}C labeled diazinon in perch (*Sarotherodon galilaeus*). In comparison with other lipophilic pesticides (i.e., DDT, lindane), the bioaccumulation factor of diazinon was found to be lower by a factor of >10, and both the compound and its metabolites were eliminated quickly (9% of bioaccumulated diazinon was left after 3 days). Kanazawa (1978) exposed seven species of freshwater organisms to 10 and 50 μg/L diazinon for seven days, and found that the bioconcentration ratios of fishes were generally larger than those of crustaceans and gastropods, and also found that diazinon is quickly eliminated from tissues (~8 days).

Deneer *et al.* (1999) found the lethal body burden of diazinon in guppies to range from 1.8 - 2.1 μmol/g, and that the log BCF of diazinon ranged from 2.17-2.35, depending on exposure level. The study performed by Keizer *et al.* (1991) also used the guppy (*Poecilia reticulata*), and compared uptake in the guppy to the zebra fish (*Danio rerio*). It was found that differences in metabolism play a pivotal role in the rate of bioaccumulation, as the LC_{50} values and BCFs between these two species varied greatly (0.8 mg/L and 39 in the guppy, 8 mg/L and > 300 in the zebra fish).

Three studies assessing the bioaccumulation of diazinon were performed by Tsuda *et al.* (1990; 1995a; 1997b). The 1990 study found BCFs for diazinon ranging from 20.9 - 111.1 in the muscle, liver, kidney, and gallbladder, and second-order excretion. In 1995, it was found that bioconcentration in the Japanese killifish (*Oryzias latipes*) plateaued at 24 hr and that a mixture of pesticides including diazinon reached a BCF plateau more rapidly. The excretion rate of diazinon was found to be similar to other OP pesticides (fenthion, fenitrothion). The 1997 study looked at correlations between the BCFs of four fishes (guppy, killifish, goldfish, white cloud mountain fish) exposed to 2.1 - 2.9 μg/L diazinon (in addition to 10 other OP pesticides), and found that the BCFs of diazinon and other pesticides correlated more closely between different fishes than did the octanol-water partition coefficient (K_{ow}). The BCF of diazinon peaked at 120 hours in all fishes with the exception of the white cloud mountain fish (72 hr BCF peak), and ranged from 35.7 in the white cloud mountain fish to 132 in the male guppy.

In summary, most studies found that diazinon is relatively quickly eliminated from tissues after placing organisms in clean water (3-8 days), and that steady-state is reached within a few days. BCF values varied widely amongst different species.

To check that these criteria are protective of terrestrial animals that may consume aquatic organisms, a bioaccumulation factor will be used to estimate the water concentration that would roughly equate to a reported toxicity value for such terrestrial wildlife. No BAF or BMF values were found for diazinon and few dietary LC_{50} values were available for wildlife. Only one NOEC was available for a relevant terrestrial animal of 8.3 mg/kg for mallard duck reproduction (USEPA 2004). The oral LC_{50} of 1.44 mg/kg (USEPA 2004) and 3.54 mg/kg (Hudson *et al.* 1984) is lower, but dose is mg diazinon per kg body weight. Translating that value to a food concentration that a duck might consume in one feeding would probably increase the value significantly. A conservative estimate can be made using the lowest NOEC of 8.3 mg/kg for mallard duck. This value will be translated to a water value using a default BMF value of 2 according to the section 3-7.1 of the methodology (TenBrook *et al.* 2009a):

$NOEC_{water}$ = 8.3 mg/kg ÷ (186 * 2) = 0.0223 mg/L = 22.3 μg/L

This value is well above the acute and chronic criteria of 0.2 μg/L and 0.1 μg/L, respectively, and therefore the criteria should be protective of animals feeding on aquatic organisms.

14. Ecosystem and other studies

Four studies of diazinon effects on microcosms, mesocosm and model ecosystems were rated acceptable (R or L reliability rating). In Giddings *et al.* (1996) diazinon was applied in a range of concentrations (2.0 - 500 μg/L) to aquatic microcosms (sediment from pond including invertebrates and plants with bluegill sunfish added). The LOEC was near the 10^{th} percentile of single-species LC_{50} values, at 9.2 μg/L, and the NOEC was 4.3 μg/L (70-d averages). Cladoceran species were found to be the least tolerant, while gastropods and rotifers were the most tolerant species. Arthur *et al.* (1983) used three outdoor experimental channels to assess the effect of a 12 week exposure to diazinon using a low treatment of 0.3 μg/L and high treatment of 6 μg/L (nominal concentrations). Then the dose was increased for 4 weeks to higher concentrations (12 and 30 μg/L). Macroinvertebrate and insect emergence, density, drift and percent occurrence were monitored. Effects on amphipods and insects were seen in the lowest treatment with lower numbers of mayflies and damselflies emerging from treated channels. Flatworms, gastropods, isopods and chironomids were most tolerant to diazinon. Werner *et al.* (2004) exposed larval fish (fathead minnows, rainbow trout), waterfleas (*Ceriodaphnia dubia, Simocephalus vetelus*) and midge larvae (*Chironomus riparius*) to stormwater runoff collected in a California orchard after application of diazinon and esfenvalerate (in separate areas), following two consecutive rainstorms. Diazinon concentrations measured in orchard runoff were 277-340 μg/L (first rain storm), and 10.7-19.5 μg/L (second rain storm). All runoff was toxic to *C. dubia,* and toxicity to the fish and midge varied by treatment. Moore *et al.* (2007) investigated the role of organic matter in pesticide exposure in a constructed wetland by exposing leaf litter to 160 μg/L of diazinon. *Hyalella azteca* survival was affected by exposure to contaminated leaf-litter removed from the wetlands (measured diazinon residues of ≥ 60 μg/kg). The concentrations tested in these ecosystem studies are all well above the criteria, except the study by Arthur *et al.* (1983) that documented effects at 0.3 µg/L, which is only slightly above the derived criteria.

Studies that did not receive an R or L reliability rating but were considered of interest are included in Appendix A. These studies implicated various levels of diazinon in effluents and run-off in California as part of the cause of toxicity to organisms. These studies did not meet the criteria for ecosystem or mesocosm evaluations, primarily because other contaminants were often present and effects could not be related to diazinon with certainty. Most of the measured diazinon concentrations were also above the criteria. Given the results of the above studies, it appears that an acute criterion of 0.2 µg/L and a chronic criterion of 0.2 µg/L will be protective. However, effects were seen at 0.3 µg/L, as described above (Arthur *et al.* 1983), and this value is very close to the chronic criterion of 0.2 µg/L. While this study is not conclusive enough to demonstrate that 0.2 µg/L will not be protective (there is no NOEC), it adds some support for use of a slightly lower chronic criterion of 0.1 µg/L, calculated from either the lower confidence limit from the estimation using the whole data set or the median estimate using the lower subset, as discussed in sections 8 and 12.

15. Threatened and endangered species

Current lists of state and federally listed threatened and endangered plant and animal species in California were obtained from the California Department of Fish and Game web site (www.dfg.ca.gov/hcpb/species/t_e_spp/tespp.shtml; CDFG 2006a, b). None of the listed animals or plants is represented in the acute or chronic data set. However, some of the listed species are represented in the acute data set by members of the same family or genus. For these, the USEPA interspecies correlation estimation (ICE v. 1.0; USEPA 2003) software was used to estimate toxicity values. Table 10 summarizes the results of the ICE analyses. The values in Table 10 range from 730 µg/L for *Oncorhynchus mykiss* (steelhead) to 2750 µg/L for *Ptychocheilus lucius* (Colorado squawfish), indicating that the acute criterion of 0.2 µg/L should be protective of these species.

Additionally, the supplemental data set (Table 8) contains data for endangered species. The supplemental data set includes LC_{50} values for *Oncorhynchus mykiss* of 90-2760 µg/L. The value estimated above for *O. mykiss* does fall within this range. *Oncorhynchus tshawytscha* (Chinook salmon) is listed as federally threatened or endangered, depending on season and location. The supplemental data set contains an LC_{50} of 545,000 µg/L and a MATC of 70,700 µg/L for embryos of *O. tshawytscha* and an LC_{50} of 29,500 µg/L for the alevins of *O. tshawytscha*. Although not as reliable, these data support that the criteria is protective of these endangered salmonids. *Cyprinella monacha* and *Notropis mekistocholae* are threatened and endangered species also, although they reside in the Southwestern U.S., not in California. The criteria in this report are protective based on the reported toxicity values for these species: an IC_{25} of 4115 µg/L for *C. monacha* and 199 µg/L for *N. mekistocholae.*

There was one algal study (the only plant value) that rated reliable and relevant for criteria derivation, but no algae species are on the state or federal endangered, threatened or rare species lists. As discussed in the chlorpyrifos criteria report of the methodology (section 4-4.0, TenBrook *et al.* 2009a), plants are relatively insensitive to organophosphate insecticides, and therefore the calculated criteria should be protective.

Based on the available data and estimated values for animals, there is no evidence that the calculated acute and chronic criteria will be underprotective of threatened and endangered species. However, the caveat of this assessment is that no data were found for effects of diazinon on federally endangered cladocerans or insects, or acceptable surrogates (i.e., in the same family), which are the most sensitive species in the acute criterion data set.

16. Harmonization with air or sediment criteria

This section addresses how the maximum allowable concentration of diazinon might impact life in other environmental compartments through partitioning. The only available sediment criteria for diazinon is estimated based on partitioning from water using the USEPA water quality criteria (USEPA 2006a), making it useless to estimate back to a water concentration. There are no other federal or state sediment or air quality standards for diazinon (California Air Resources Board 2005, USEPA 2006b, California Department of Water Resources 1995). However, diazinon can be present in the atmosphere and transported via rain and fog. Diazinon was measured in rain (2.00-0.0013 μg/L), snow (up to 14 ng/L), and fog water (76.30-0.0013 μg/L) in the Sierra Nevada mountains, likely transported there from the California Central Valley (McConnell *et al.* 1998, Zabik & Seiber 1993). Diazinon has been measured in fog water at 0.1-0.3 μg/L, near Parlier, CA (Glotfelty *et al.* 1990) and rain in Europe (0.1-0.3 μg/L, Scharf *et al.* 1992 and 0.008-0.21 μg/L, Charizopoulos & Papadopoulou-Mourkidou 1999). Since there are no atmospheric limits for diazinon, no estimations on the partitioning from water to the atmosphere are made.

17. Limitations, assumptions, and uncertainties

The assumptions, limitations and uncertainties involved in criteria generation are available to inform environmental managers of the accuracy and confidence in criteria. Chapter 2 of the methodology (TenBrook *et al.* 2009a) discusses these points for each section as different procedures were chosen, such as the list of assumptions associated with using an SSD, included in section 2-3.1.5.1, and reviews them in section 2-7.0. This section summarizes any data limitations that affected the procedure used to determine the final diazinon criteria. The different calculations of distributional estimates included in section 7 of this report may be used to consider the uncertainty in the resulting acute criterion.

For diazinon, the major limitation was lack of data in the chronic data set. Two of five taxa requirements were not met (the benthic crustacean and insect) which precluded the use of a SSD; therefore, an ACR was used to derive the chronic criterion. Three acceptable ACRs were available, but because of the wide range of values between fish and the Cladocerans only the value for the Cladoceran was used (according to the method, section 3-4.2.1, TenBrook *et al.* 2009a). This left the chronic criterion to be derived from only this one value. When comparing this criterion (0.20 µg/L) to the supplemental data set it seems that chronic effects may occur at lower concentrations (0.07 - 0.16 µg/L, section 12). This is difficult to confirm as these studies lack several quality control parameters and the few other supplemental values are only slightly higher (0.22 -0.24 µg/L). To ensure protection a lower chronic value is recommended.

Bimodality is apparent in this data set; however, the final data could be fit to a Burr Type III distribution. Because bimodality is apparent in the data set and bimodality dictated that other diazinon data sets be split when using the Burr Type III distribution (e.g., the EPA diazinon data set as discussed in section 2-3.1.1 of TenBrook *et al.* 2009a and Appendix B of this report), the calculation with the lower subset is included for consideration in section 7. The acute criterion using only the lowest subset of acute toxicity values was calculated as 0.10 µg/L. Additionally, the log-triangular calculation (using the final data set in this report) provided an acute criterion of 0.09 µg/L. These alternative calculations support lowering the criteria.

18. Final criteria statement

Aquatic life in the Sacramento River and San Joaquin River basins should not be affected unacceptably if the four-day average concentration of diazinon does not exceed 0.1 µg/L (100 ng/L) more than once every three years on the average and if the one-hour average concentration does not exceed 0.2 µg/L (200 ng/L) more than once every three years on the average.

The final acute criterion was derived using the SSD procedure (section 7). The chronic criterion was derived by use of an ACR (section 8), but after reviewing the supplemental data set, a lower value is recommended (section 12 and 17) based on the calculation with the lower acute subset (sections 7 and 8).

This acute criterion is slightly higher than the EPA diazinon acute criterion of 170 ng/L (USEPA 2005); however, the difference is mostly due to rounding. The chronic value is lower than the EPA diazinon chronic freshwater criteria of 170 ng/L (USEPA 2005).

The derived criteria are higher than current EPA acute criterion, but similar to the current chronic water quality objectives for the lower San Joaquin River, and those proposed for the Sacramento and San Joaquin River Delta, of 160 and 100 ng/L (CVRWQCB 2005, CVRWQCB 2006b). The derived criteria are both higher than criteria of 80 and 50 ng/L for waterways in Sacramento County (CVRWQCB 2004). These objectives are based on criteria derived by the California Department of Fish and Game using the USEPA (1985) methodology (Siepmann & Finlayson 2000), but with a different data set than that used by USEPA (2005).

The criteria from the different agencies are very similar overall. The small differences seem to be due to both the method used to construct the SSD and the data used. The data that was used to calculate the acute criteria in this report were put through the USEPA log triangular calculation (USEPA 1985). A final acute value (5^{th} percentile value) of 0.18 μg/L was obtained. This value would be divided by two give a criterion maximum concentration of 0.090 μg/L. Fitting the USEPA data set to a Burr Type III distribution using the BurrliOZ program yields 0 for the 5^{th} percentile value with 50% confidence limits. This is likely due to the bimodal distribution that is more apparent in EPA's data set (see Appendix B, Figure B-1). Using only the eight most sensitive genus mean acute values a 5^{th} percentile value of 0.41 μg/L was obtained, and divided by two, yields an acute criterion of 0.21 μg/L, which is similar to the acute criterion in this report. A more detailed comparison of the criteria reports of EPA, CDFG and this one is included in Appendix B.

For the chronic criterion, all three reports used the same method, an ACR, and fairly similar results were obtained. Using available data, a chronic criterion of 0.2 μg/L was calculated, which is similar to EPA's value of 0.17. However, in light of other information a final chronic criterion of 0.10 μg/L was recommended, which is equivalent to the criteria derived by CDFG and the water quality objective used for the lower San Joaquin River. The difference between the CDFG and the EPA chronic criterion is primarily due to the use of an ACR of 3 versus 2, respectively. Table B-5 (Appendix B), lists data used and the reasons agencies omitted certain studies or values in calculating the ACR.

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Data Tables

Table 3. Final acute toxicity data set for diazinon. All studies were rated relevant and reliable (RR) and were conducted at standard temperature. Values in bold are species mean acute values. S: static; SR: static renewal; FT: flow-through.

Species	Common identifier	Family	Test type	Meas/ Nom	Chemical grade	Duration	Temp (°C)	Endpoint	Age/size	LC/EC_{50} (μg/L)	Reference
Ceriodaphnia dubia	Cladoceran	Daphniidae	SR	Meas	87.3%	96 h	24.7	Mortality	< 24 h	0.436	CDFG 1998a
Ceriodaphnia dubia	Cladoceran	Daphniidae	SR	Meas	88.0%	96 h	24.4	Mortality	< 24 h	0.47	CDFG 1992b
Ceriodaphnia dubia	Cladoceran	Daphniidae	SR	Meas	88.0%	96 h	24.4	Mortality	< 24 h	0.507	CDFG 1992a
Ceriodaphnia dubia	Cladoceran	Daphniidae	S	Meas	99.0%	96 h	25	Mortality	< 24 h	Test 1: 0.32 Test 2: 0.35	Bailey et al. 1997
Ceriodaphnia dubia	Cladoceran	Daphniidae	S	Meas	Analytical	48 h	25	Mortality	< 24 h	0.33	Bailey et al. 2000
Ceriodaphnia dubia	Cladoceran	Daphniidae	S	Meas	99.0%	48 h	25	Mortality	< 24 h	Test 1: 0.38 Test 2: 0.33	Bailey et al. 2001
Ceriodaphnia dubia	Cladoceran	Daphniidae	S	Meas	99.8%	48 h	25	Mortality	< 24 h	0.21	Banks et al. 2005
								Species Mean		**0.36**	
Chironomus tentans	Insect	Chironomidae	S	Nom	95.0%	96 h	23	Mortality/ Immobility	3rd instar	**10.7**	Ankley & Collyard 1995
Daphnia magna	Cladoceran	Daphniidae	FT	Meas	87.7%	96 h	20	Mortality/ Immobility	< 24 h	**0.52**	Surprenant 1988a
Gammarus pseudolimnaeus	Amphipod	Gammaridae	SR	Meas	100.0%	96 h	18	Mortality	Mature	**16.82**	Hall & Anderson 2005

Species	Common identifier	Family	Test type	Meas/ Nom	Chemical grade	Duration	Temp (°C)	Endpoint	Age/size	LC/EC$_{50}$ (µg/L)	Reference
Hyalella azteca	Amphipod	Hyalellidae	S	Meas	98.0%	96 h	20	Mortality	14-21 d	**4.3**	Anderson & Lydy 2002
Jordanella floridae	Flagfish	Cyprinodontidae	FT	Meas	92.5%	96 h	25	Mortality	6-7 wk	Test 1: 1500 Test 2: 1800	Allison & Hermanutz 1977
								Species Mean		**1643**	
Lepomis macrochirus	Bluegill	Centrarchidae	FT	Meas	92.5%	96 h	25	Mortality	1 yr	Test 1: 480 Test 2: 440	Allison & Hermanutz 1977
								Species Mean		**460**	
Neomysis mercedis	Mysid	Mysidae	SR	Meas	88.0%	96 h	17	Mortality	< 5 d	3.57	CDFG 1992c
Neomysis mercedis	Mysid	Mysidae	SR	Meas	88.0%	96 h	17.5	Mortality	< 5 d	4.82	CDFG 1992d
								Species Mean		**4.15**	
Physa spp	Pond snail	Physidae	SR	Meas	87.0%	96 h	21.6	Mortality	Juvenile	**4441**	CDFG 1998b
Pimephales promelas	Fathead minnow	Cyprinidae	FT	Meas	92.5%	96 h	25	Mortality	15-20 wk	Test 1:6800 Test 2:6600 Test 3: 10,000	Allison & Hermanutz 1977
Pimephales promelas	Fathead minnow	Cyprinidae	FT	Meas	87.1%	96 h	24.5	Mortality	31 d	9350	Geiger et al. 1988

Species	Common identifier	Family	Test type	Meas/ Nom	Chemical grade	Duration	Temp (°C)	Endpoint	Age/size	LC/EC$_{50}$ (µg/L)	Reference
Pimephales promelas	Fathead minnow	Cyprinidae	FT	Meas	87.1%	96 h	23.5-26	Mortality	Newly hatched	6900	Jarvinen & Tanner 1982
								Species Mean		**7804**	
Pomacea paludosa	Snail	Ampullariidae	FT	Meas	87.0%	96 h	26-27.4	Mortality	1d, 7 d	Test 1: 2950 Test 2: 3270 Test 3: 3390	Call 1993
								Species Mean		**3198**	
Procloeon sp.	Insect	Baetidae	SR	Meas	99.0%	48 h	22.1	Mortality	0.5-1 cm	Test 1: 1.53 Test 2: 2.11 Test 3: 1.77	Anderson et al. 2006
								Species Mean		**1.79**	
Salvelinus fontinalis	Brook trout	Salmonidae	FT	Meas	92.5%	96 h	12	Mortality	1 yr	Test 1: 800 Test 2: 450 Test 3: 1050	Allison & Hermanutz 1977
								Species Mean		**723**	

Table 4. Acceptable acute data excluded in data reduction process. S: static; SR: static renewal; FT: flow-through.

Species	Common identifier	Family	Test type	Meas/ Nom	Chemical grade	Duration	Temp (^oC)	Endpoint	Age/size	LC/EC_{50} (µg/L)	Reference	Reason for exclusion
Ceriodaphnia dubia	Cladoceran	Daphniidae	S	Nom	99.8%	48 h	25	Mortality	< 24 h	0.45	Banks et al. 2003	1
Chironomus tentans	Insect	Chironomidae	S	Meas	98.0%	96 h	20	Mortality/ Immobility	4th instar	30	Belden & Lydy 2000	2
Chironomus tentans	Insect	Chironomidae	S	Meas	99.5%	96 h	21	Mortality/ Immobility	4th instar	19.1	Lydy & Austin 2004	2
Pimephales promelas	Fathead minnow	Cyprinidae	SR	Meas	99.4%	96 h	20	Mortality	7 d	Test 1: 6393 Test 2: 5048 Test 3: 7969	Denton et al. 2003	3
Pimephales promelas	Fathead minnow	Cyprinidae	S	Meas	87.1%	96 h	23.5-26	Mortality	Newly hatched	2100	Jarvinen & Tanner 1982	3
Pimephales promelas	Fathead minnow	Cyprinidae	S	Meas	87.1%	96 h	23.5-26	Mortality	Newly hatched	4300	Jarvinen & Tanner 1982	3

Reasons for exclusion
1. Test with measured concentrations available
2. More sensitive lifestage available
3. Flow-through test available

Table 5. Final chronic toxicity data set for diazinon. All studies were rated relevant and reliable (RR). Values in bold are species mean chronic values. S: static; SR: static renewal; FT: flow-through.

Species	Common identifier	Test type	Meas/ Nom	Chemical	Duration	Temp (°C)	Endpoint	Age/size	NOEC (μg/L)	LOEC (μg/L)	MATC (μg/L)	Reference
Daphnia magna	Cladoceran	FT	Meas	87.7%	21 d	20	Mortality/ immobility	< 24 h	0.17	0.32	**0.23**	Surprenant 1988a
Pimephales promelas	Fathead minnow	FT	Meas	92.5%	274 d	25	Mortality	5-d	28	60.3	41	Allison & Hermanutz 1977
Pimephales promelas	Fathead minnow	FT	Meas	87.1%	32 d	23.5-26.0	Weight	Newly hatched	50	90	67	Jarvinen & Tanner 1982
Pimephales promelas	Species mean										**54**	
Salvelinus fontinalis	Brook trout	FT	Meas	92.5%	173 d	± 1°C; variable acc. to date	Mortality	1 yr	4.8	9.6	**6.8**	Allison & Hermanutz 1977
Selenastrum capricornutum	Green algae	S	Meas	87.7%	7 d	24	Mean standing crop, cells/mL	6-8 d old culture	-----	-----	**EC_{50} 6,500**	Hughes 1988
Selenastrum capricornutum	Green algae	S	Meas	87.7%	7 d	24	Mean standing crop, cells/mL	6-8 d old culture	-----	-----	**EC_{25} 4,250**	Hughes 1988

Table 6. Acceptable chronic data excluded in data reduction process. S: static; SR: static renewal; FT: flow-through.

Species	Common identifier	Test type	Meas/ Nom	Chemical	Duration	Temp (°C)	Endpoint	Age/size	NOEC (µg/L)	LOEC (µg/L)	MATC (µg/L)	Reference	Reason for exclusion
Pimephales promelas	Fathead minnow	FT	Meas	87.1%	32 d	23.5-26.0	Mortality	Newly hatched	140	290	200	Jarvinen & Tanner 1982	1
Pimephales promelas	Fathead minnow	FT	Meas	87.7%	34 d	25	Length	Embryo	92	170	125	Surprenant 1988b	1

<u>Reasons for exclusion</u>

1. More sensitive endpoint available

Table 7. Calculation of the final acute-to-chronic ratio. Values in bold were used in the calculation.

Species	Common identifier	Reference	LC_{50} (µg/L)	Chronic Endpoint	MATC (µg/L)	ACR (LC_{50}/MATC)	Species Mean ACR
Daphnia magna	Cladoceran	Surprenant 1988a	0.52	21-d Mortality/ immobility	0.23	2.3	**2.3**
Pimephales promelas	Fathead minnow	Allison & Hermanutz 1977	7800	274-d Mortality	41	190	
Pimephales promelas	Fathead minnow	Jarvinen & Tanner 1982	6900	32-d Weight	67	103	**140**
Salvelinus fontinalis	Brook trout	Allison & Hermanutz 1977	723	173-d Mortality	6.8	106	**106**
Assumed value							**12.4**
						Final ACR	**26**

Table 8. Studies excluded from criteria derivation (rated RL, LR, or LL; L = less relevant or less reliable). S = static, SR = static renewal, FT = flow-through; NR = not reported

Species	Common identifier	Test type	Meas/ Nom	Chemical grade	Duration	Temp (°C)	Endpoint	Age/size	LC/EC_{50} (µg/L)	MATC (µg/L)	Reference	Rating	Reason for rating
Anguilla anguilla	European eel	S	Nom	92.0%	96 h	20	Mortality	20-30 g	80	--------	Ferrando et al. 1991	LL	3,6
Various	Bacteria	S	Nom	Reagent	22 h	21	Dissolved oxygen depletion	NR	--------	--------	Bauer et al. 1981	LL	5,6
Brachionus calyciflorus	Rotifer	S	Nom	92.0%	24 h	25	Mortality	Newly hatched	29,220	--------	Fernández-Casalderrey et al. 1992a	RL	6
Brachionus calyciflorus	Rotifer	SR	Nom	92.0%	10-11 d	25	Net reproductive rate	Neonates	5,200	--------	Fernández-Casalderrey et al. 1992b	RL	6
Brachionus calyciflorus	Rotifer	SR	Nom	92.0%	10-11 d	25	Generation time	Neonates	8,490	--------	Fernández-Casalderrey et al. 1992b	RL	6
Brachionus calyciflorus	Rotifer	SR	Nom	92.0%	10-11 d	25	Life expectancy	Neonates	12,300	--------	Fernández-Casalderrey et al. 1992b	RL	6
Brachionus calyciflorus	Rotifer	S	Nom	96.0%	5 hr	NR	Filtration rate	Neonates	14,390	9,900	Fernández-Casalderrey et al. 1992c	RL	2,6
Brachionus calyciflorus	Rotifer	S	Nom	96.0%	5 hr	NR	Ingestion rate	Neonates	14,220	9,900	Fernández-Casalderrey et al. 1992c	RL	2,6
Brachionus calyciflorus	Rotifer	S	Nom	NR	48 h	25	Intrinsic rate of increase	< 2 h	11,000	10,000	Snell & Moffat 1992	LL	1,6

Species	Common identifier	Test type	Meas/ Nom	Chemical grade	Duration	Temp (°C)	Endpoint	Age/size	LC/EC$_{50}$ (µg/L)	MATC (µg/L)	Reference	Rating	Reason for rating
Brachydanio rerio	Zebrafish	FT	Meas	Analytical	42 d	26	Mortality	Embryos	--------	--------	Bresch 1991	LR	5
Carassius auratus	Goldfish	------	------	Technical	48 h	------	Mortality	------	5,100	--------	Nishiuki & Hashimoto 1967	LL	6
Carassius auratus	Goldfish	S	Nom	91%	96 h	11-17	Mortality	2.5-6 cm	9000	--------	Beliles 1965	RL	6
Caridina laevis	Shrimp	S	Nom	60%	96 h	26-27	Mortality	Juvenile 8-10mm	0.59	--------	Sucahyo et al. 2008	LR	1
Ceriodaphnia dubia	Cladoceran	SR	Nom	99.0%	3 broods	25	Biomass	< 24 h	--------	--------	Dwyer et al. 2005	LL	5,6
Ceriodaphnia dubia	Cladoceran	S	Nom	85.0%	48 h	25	Mortality	< 24 h	0.57	--------	Norberg King 1987	LL	6
Ceriodaphnia dubia	Cladoceran	S	Nom	85.0%	48 h	25	Mortality	< 24 h	0.66	--------	Norberg King 1987	LL	6
Ceriodaphnia dubia	Cladoceran	S	Nom	85.0%	48 h	25	Mortality	< 24 h	0.57	--------	Norberg King 1987	LL	6
Ceriodaphnia dubia	Cladoceran	S	Nom	85.0%	48 h	25	Mortality	< 48 h	0.35	--------	Norberg King 1987	LL	6
Ceriodaphnia dubia	Cladoceran	S	Nom	85.0%	48 h	25	Mortality	< 48 h	0.35	--------	Norberg King 1987	LL	6

Species	Common identifier	Test type	Meas/ Nom	Chemical grade	Duration	Temp (°C)	Endpoint	Age/size	LC/EC_{50} (µg/L)	MATC (µg/L)	Reference	Rating	Reason for rating
Ceriodaphnia dubia	Cladoceran	S	Nom	85.0%	48 h	25	Mortality	< 6 h	0.25	--------	Norberg King 1987	LL	6
Ceriodaphnia dubia	Cladoceran	S	Nom	85.0%	48 h	25	Mortality	< 24 h	0.33	--------	Norberg King 1987	LL	6
Ceriodaphnia dubia	Cladoceran	S	Nom	85.0%	48 h	25	Mortality	< 48 h	0.35	--------	Norberg King 1987	LL	6
Ceriodaphnia dubia	Cladoceran	S	Nom	85.0%	48 h	25	Mortality	< 48 h	0.59	--------	Norberg King 1987	LL	6
Ceriodaphnia dubia	Cladoceran	S	Nom	85.0%	48 h	25	Mortality	< 48 h	0.43	--------	Norberg King 1987	LL	6
Ceriodaphnia dubia	Cladoceran	S	Nom	85.0%	48 h	25	Mortality	< 48 h	0.35	--------	Norberg King 1987	LL	6
Ceriodaphnia dubia	Cladoceran	S	Nom	85.0%	48 h	25	Mortality	< 24 h	0.36	--------	Norberg King 1987	LL	6
Ceriodaphnia dubia	Cladoceran	SR	Meas	85.0%	48 h	25	Mortality	< 6 h	0.66	--------	Norberg King 1987	LL	6
Ceriodaphnia dubia	Cladoceran	SR	Meas	85.0%	7 d	25	Survival, Number of young/ female	< 6 h	--------	0.34	Norberg King 1987	LL	6
Chironomus riparius	Insect	S	Nom	97%	24 h	11	Immobility	4 th instar	64.9	--------	Landrum et al 1999	LL	4,6

Species	Common identifier	Test type	Meas/ Nom	Chemical grade	Duration	Temp (°C)	Endpoint	Age/size	LC/EC_{50} (µg/L)	MATC (µg/L)	Reference	Rating	Reason for rating
Chironomus riparius	Insect	S	Nom	97%	24 h	18	Immobility	4 th instar	24.4	--------	Landrum et al 1999	LL	4,6
Chironomus riparius	Insect	S	Nom	97%	24 h	25	Immobility	4 th instar	11.6	--------	Landrum et al 1999	LL	4,6
Chironomus riparius	Insect	S	Meas	99.7%	48 h	20	Mortality	1st instar	32	--------	Stuijfzand et al. 2000	RL	6
Chironomus riparius	Insect	S	Meas	99.7%	96 h	20	Mortality	1st instar	22.8	--------	Stuijfzand et al. 2000	RL	6
Chironomus riparius	Insect	S	Meas	99.7%	48 h	20	Activity	1st instar	22.6	--------	Stuijfzand et al. 2000	RL	2,6
Chironomus riparius	Insect	S	Meas	99.7%	48 h	20	Growth	1st instar	35.2	--------	Stuijfzand et al. 2000	RL	6
Chironomus riparius	Insect	S	Meas	99.7%	96 h	20	Growth	1st instar	57.3	--------	Stuijfzand et al. 2000	RL	6
Chironomus riparius	Insect	S	Meas	99.7%	48 h	20	Mortality	4th instar	> 268	--------	Stuijfzand et al. 2000	RL	5,6
Chironomus riparius	Insect	S	Meas	99.7%	96 h	20	Mortality	4th instar	167	--------	Stuijfzand et al. 2000	RL	6
Chironomus riparius	Insect	S	Meas	99.7%	48 h	20	Activity	4th instar	19.9	--------	Stuijfzand et al. 2000	RL	2.6

Species	Common identifier	Test type	Meas/ Nom	Chemical grade	Duration	Temp (°C)	Endpoint	Age/size	LC/EC_{50} (µg/L)	MATC (µg/L)	Reference	Rating	Reason for rating
Chironomus riparius	Insect	S	Meas	99.7%	96 h	20	Activity	4th instar	17.9	--------	Stuijfzand et al. 2000	RL	2,6
Chironomus tentans	Insect	S	Nom	99.5%	96 h	21	Normal swimming motion	4th instar	31.3	--------	Schuler et al. 2005	LL	4,6
Chironomus tepperi	Insect	S	Nom	800g/L	24 h	25	Mortality	4th instar	35.5	--------	Stevens 1992	LL	4,6
Cyprinella monacha	Spotfin chub	SR	Nom	99.0%	7 d	25	Biomass	< 24 h	4,115 (IC25)	--------	Dwyer et al. 2005	RL	6
Cyprinus carpio	Carp	SR	Nom	35.0%	96 h	25	Mortality	Juvenile	Test 1: 4,974.5 Test 2: 3,426.8	--------	Alam & Maughan 1992	LL	1,6
Cyprinus carpio	Carp	SR	Nom	63.0%	24 h	24	Mortality	Embryos	999	--------	Aydin & Köprücü 2005	LL	1,6
Cyprinus carpio	Carp	SR	Nom	63.0%	24 h	24	Mortality	Larvae	3,688	--------	Aydin & Köprücü 2005	LL	1,6
Cyprinus carpio	Carp	SR	Nom	63.0%	48 h	24	Mortality	Larvae	2,903	--------	Aydin & Köprücü 2005	LL	1,6
Cyprinus carpio	Carp	SR	Nom	63.0%	72 h	24	Mortality	Larvae	2,358	--------	Aydin & Köprücü 2005	LL	1,6
Cyprinus carpio	Carp	SR	Nom	63.0%	96 h	24	Mortality	Larvae	1,530	--------	Aydin & Köprücü 2005	LL	1,6

Species	Common identifier	Test type	Meas/ Nom	Chemical grade	Duration	Temp (°C)	Endpoint	Age/size	LC/EC$_{50}$ (µg/L)	MATC (µg/L)	Reference	Rating	Reason for rating
Cyprinus carpio	Carp	------	------	Technical	48 h	------	Mortality	------	3,200	--------	Nishiuki & Hashimoto 1967	LL	3,6
Cyrnus trimaculatus	Insect	S	Meas	99.7%	96 h	20	Mortality	2nd instar	1.1	--------	Van Der Geest et al. 2000b	LL	3,6
Danio rerio	Zebrafish	SR	Nom	NR	96 h	26, 28, 30, 33.5	Mortality, Heart Rate, Hatching Success	Eggs	--------	--------	Osterauer & Koehler 2008	LL	1,5
Daphnia magna	Cladoceran	S	Nom	95-99%	48 h	25	Mortality	< 48 h	0.8	--------	Ankley et al. 1991	RL	6
Daphnia magna	Cladoceran	SR	Nom	99.0%	21 d	17-19	Mortality/ Immobility	< 24 h	--------	0.24	Dortland 1980	RL	6
Daphnia magna	Cladoceran	SR	Nom	99.0%	21 d	17-19	Reproduction	< 24 h	--------	0.24	Dortland 1980	RL	6
Daphnia magna	Cladoceran	S	Nom	92.0%	24 h	22	Mortality	< 24 h	0.86	--------	Fernández-Casalderrey et al. 1995	RL	6
Daphnia magna	Cladoceran	SR	Nom	92.0%	21 d	22	Longevity	< 24 h	--------	0.16	Fernández-Casalderrey et al. 1995	RL	6
Daphnia magna	Cladoceran	SR	Nom	92.0%	21 d	22	Mean number of broods	< 24 h	--------	0.16	Fernández-Casalderrey et al. 1995	RL	6
Daphnia magna	Cladoceran	SR	Nom	92.0%	21 d	22	Mean days to reproduction	< 24 h	--------	0.24	Fernández-Casalderrey et al. 1995	RL	6

Species	Common identifier	Test type	Meas/ Nom	Chemical grade	Duration	Temp (°C)	Endpoint	Age/size	LC/EC_{50} (µg/L)	MATC (µg/L)	Reference	Rating	Reason for rating
Daphnia magna	Cladoceran	S	Nom	Analytical	48 h	21	Immobility	< 24 h	0.87	--------	Kikuchi et al. 2000	RL	6
Daphnia magna	Cladoceran	SR	Nom	96.1%	7 d	22	Mortality	< 24 h	--------	0.22	Sánchez et al. 1998	RL	6
Daphnia magna	Cladoceran	SR	Nom	96.1%	21 d	22	Young per adult	< 24 h	--------	0.07	Sánchez et al. 1998	RL	6
Daphnia magna	Cladoceran	SR	Nom	96.1%	21 d	22	Brood size	< 24 h	--------	0.07	Sánchez et al. 1998	RL	6
Daphnia magna	Cladoceran	SR	Nom	96.1%	21 d	22	Broods per adult	< 24 h	--------	0.07	Sánchez et al. 1998	RL	6
Daphnia magna	Cladoceran	SR	Meas	96.1%	21 d	22	Longevity, F_0 generation	< 24 h	0.67	--------	Sánchez et al. 2000	RL	6
Daphnia magna	Cladoceran	SR	Meas	96.1%	21 d	22	Young per female, F_0 generation	< 24 h	0.35	--------	Sánchez et al. 2000	RL	6
Daphnia magna	Cladoceran	SR	Meas	96.1%	21 d	22	Brood size, F_0 generation	< 24 h	0.47	0.07	Sánchez et al. 2000	RL	6
Daphnia magna	Cladoceran	SR	Meas	96.1%	21 d	22	Broods per female, F_0 generation	< 24 h	0.43	0.07	Sánchez et al. 2000	RL	6
Daphnia magna	Cladoceran	SR	Meas	96.1%	21 d	22	Intrinsic rate of increase, F_0 generation	< 24 h	0.72	0.61	Sánchez et al. 2000	RL	6

Species	Common identifier	Test type	Meas/ Nom	Chemical grade	Duration	Temp (^{o}C)	Endpoint	Age/size	LC/EC_{50} (µg/L)	MATC (µg/L)	Reference	Rating	Reason for rating
Daphnia magna	Cladoceran	SR	Meas	96.1%	21 d	22	Longevity, first brood, F_1 generation	< 24 h	0.41	--------	Sánchez et al. 2000	RL	6
Daphnia magna	Cladoceran	SR	Meas	96.1%	21 d	22	Young per female, first brood, F_1 generation	< 24 h	0.2	--------	Sánchez et al. 2000	RL	6
Daphnia magna	Cladoceran	SR	Meas	96.1%	21 d	22	Brood size, first brood, F_1 generation	< 24 h	0.29	0.07	Sánchez et al. 2000	RL	6
Daphnia magna	Cladoceran	SR	Meas	96.1%	21 d	22	Broods per female, first brood, F_1 generation	< 24 h	0.29	--------	Sánchez et al. 2000	RL	6
Daphnia magna	Cladoceran	SR	Meas	96.1%	21 d	22	Intrinsic rate of increase, first brood, F_1 generation	< 24 h	0.44	0.61	Sánchez et al. 2000	RL	6
Daphnia magna	Cladoceran	SR	Meas	96.1%	21 d	22	Longevity, third brood, F_1 generation	< 24 h	0.35	0.07	Sánchez et al. 2000	RL	6
Daphnia magna	Cladoceran	SR	Meas	96.1%	21 d	22	Young per female, third brood, F_1 generation	< 24 h	0.22	0.07	Sánchez et al. 2000	RL	6
Daphnia magna	Cladoceran	SR	Meas	96.1%	21 d	22	Brood size, third brood, F_1 generation	< 24 h	0.27	0.07	Sánchez et al. 2000	RL	6

Species	Common identifier	Test type	Meas/ Nom	Chemical grade	Duration	Temp (°C)	Endpoint	Age/size	LC/EC$_{50}$ (µg/L)	MATC (µg/L)	Reference	Rating	Reason for rating
Daphnia magna	Cladoceran	SR	Meas	96.1%	21 d	22	Broods per female, third brood, F_1 generation	< 24 h	0.25	0.07	Sánchez et al. 2000	RL	6
Daphnia magna	Cladoceran	SR	Meas	96.1%	21 d	22	Intrinsic rate of increase, third brood, F_1 generation	< 24 h	0.47	0.07	Sánchez et al. 2000	RL	6
Daphnia magna	Cladoceran	S	Nom	Technical	48 h	17	Mortality	< 20 h	0.96	--------	Vilkas 1976	LL	4,6
Daphnia pulex	Cladoceran	S	Nom	Technical	48 h	15	Immobility	1st instar	0.8	--------	Johnson & Finley 1980	LL	4,6
Daphnia pulex	Cladoceran	------	------	Technical	3 h	------	Mortality	------	7.8	--------	Nishiuki & Hashimoto 1967	LL	6
Ephoron virgo	Insect	S	Meas	99.7%	96 h	20	Mortality	2-day larvae	11.8	--------	Van Der Geest et al. 2000a	LL	3,6
Ephoron virgo	Insect	S	Meas	99.7%	96 h	20	Mortality	0-2-day larvae	6.9	--------	Van Der Geest et al. 2000b	LR	3
Ephoron virgo	Insect	S	Meas	99.7%	72 h	20	Mortality	0-2-day larvae	4.7	--------	Van Der Geest et al. 2002	LR	3
Ephoron virgo	Insect	S	Meas	99.7%	96 h	20	Mortality	0-2-day larvae	1.1	--------	Van Der Geest et al. 2002	LR	3

Species	Common identifier	Test type	Meas/ Nom	Chemical grade	Duration	Temp (°C)	Endpoint	Age/size	LC/EC_{50} (µg/L)	MATC (µg/L)	Reference	Rating	Reason for rating
Gammarus fasciatus	Amphipod	S	Nom	Technical	96 h	21	Mortality	Mature	2.0	--------	Johnson & Finley 1980	LL	4,6
Gillia altilis	Mollusk	SR	Nom	88.6%	96 h	20.5-23.5	Mortality	NR	11,000	--------	Robertson & Mazzella 1989	LL	4,6
Hyalella azteca	Amphipod	S	Nom	95.0%	96 h	23	Mortality/ Immobility	7-14 d	6.51	--------	Ankley & Collyard 1995	LR	4
Hyalella azteca	Amphipod	S	Nom	NR	96 h	25	Mortality	0-2 d	6.2	--------	Collyard et al. 1994	LL	1,6
Hyalella azteca	Amphipod	S	Nom	NR	96 h	25	Mortality	2-4 d	4.2	--------	Collyard et al. 1994	LL	1,6
Hyalella azteca	Amphipod	S	Nom	NR	96 h	25	Mortality	6-8 d	4.2	--------	Collyard et al. 1994	LL	1,6
Hyalella azteca	Amphipod	S	Nom	NR	96 h	25	Mortality	8-10 d	4.5	--------	Collyard et al. 1994	LL	1,6
Hyalella azteca	Amphipod	S	Nom	NR	96 h	25	Mortality	12-14 d	3.8	--------	Collyard et al. 1994	LL	1,6
Hyalella azteca	Amphipod	S	Nom	NR	96 h	25	Mortality	16-18 d	4.5	--------	Collyard et al. 1994	LL	1,6
Hyalella azteca	Amphipod	S	Nom	NR	96 h	25	Mortality	20-22 d	4.8	--------	Collyard et al. 1994	LL	1,6

Species	Common identifier	Test type	Meas/ Nom	Chemical grade	Duration	Temp (°C)	Endpoint	Age/size	LC/EC_{50} (µg/L)	MATC (µg/L)	Reference	Rating	Reason for rating
Hyalella azteca	Amphipod	S	Nom	NR	96 h	25	Mortality	24-26 d	4.8	--------	Collyard et al. 1994	LL	1,6
Hyalella azteca	Amphipod	S	Nom	NR	24 h	20	Increase in heat shock proteins	NR	--------	0.13	Werner & Nagel 1997	LL	1,2,6
Hydropsyche angustipennis	Insect	S	Meas	99.7%	48 h	20	Mortality	5th instar	242.8	--------	Stuijfzand et al. 2000	LL	3,6
Hydropsyche angustipennis	Insect	S	Meas	99.7%	96 h	20	Mortality	5th instar	29.4	--------	Stuijfzand et al. 2000	LL	3,6
Hydropsyche angustipennis	Insect	S	Meas	99.7%	48 h	20	Mortality	1st instar	2.9	--------	Stuijfzand et al. 2000	LL	3,6
Hydropsyche angustipennis	Insect	S	Meas	99.7%	96 h	20	Mortality	1st instar	1.3	--------	Stuijfzand et al. 2000	LL	3,6
Hydropsyche angustipennis	Insect	S	Meas	99.7%	48 h	20	Mortality	1st instar	2.9	--------	Van Der Geest et al. 1999	LR	3
Hydropsyche angustipennis	Insect	S	Meas	99.7%	96 h	20	Mortality	1st instar	1.3	--------	Van Der Geest et al. 1999	LR	3
Hydropsyche angustipennis	Insect	S	Meas	99.7%	168 h	20	Mortality	1st instar	1.0	--------	Van Der Geest et al. 1999	LR	3
Lepomis macrochirus	Bluegill	S	Nom	92%	96 h	18	Mortality	1.0 g	168	--------	Johnson & Finley 1980	LL	4,6

Species	Common identifier	Test type	Meas/ Nom	Chemical grade	Duration	Temp (°C)	Endpoint	Age/size	LC/EC$_{50}$ (µg/L)	MATC (µg/L)	Reference	Rating	Reason for rating
Lepomis macrochirus	Bluegill	S	Nom	23%	96 h	21.8	Mortality	0.7 g	28,600	--------	Pennwalt Corp. 1978	LL	1,4
Lepomis macrochirus	Bluegill	S	Meas	48%	96 h	21-22	Mortality	40 mm; 0.75 g	210	55	Surprenant 1987	LR	1
Lestes congener	Insect	S	Nom	94%	96 h	25	Mortality	Late instar nymphs	50	--------	Federle & Collins 1976	RL	6
Lumbriculus variegatus	Oligochaete	S	Nom	95%	96 h	23	Mortality/ Immobility	Mixed ages	6160	--------	Ankley & Collyard 1995	LL	4,6
Moina macrocopa	Cladoceran	------	------	Technical	3 h	------	Mortality	------	26	--------	Nishiuki & Hashimoto 1967	LL	6
Moina macrocopa	Cladoceran	SR	Nom	60.0%	11-12 d	26	Survivorship	< 24 h	--------	0.32	Wong 1997	LL	1,6
Notropis mekistocholas	Cape Fear shiner	SR	Nom	99.0%	7 d	25	Biomass	< 24 h	199 (IC25)	--------	Dwyer et al. 2005	RL	6
Oncorhynchus mykiss	Rainbow trout	S	Nom	92.0%	96 h	12	Mortality	2.0 g	Test 1: 1,700 Test 2: 2,760	--------	Johnson & Finley 1980	LL	4,6
Oncorhynchus mykiss	Rainbow trout	SR	Nom	98.0%	24 h	NR	Cholinesterase inhibition; muscarinic cholinergic receptor number	40 d	--------	--------	Beauvais et al. 2000	LL	2,5

Species	Common identifier	Test type	Meas/ Nom	Chemical grade	Duration	Temp (°C)	Endpoint	Age/size	LC/EC$_{50}$ (µg/L)	MATC (µg/L)	Reference	Rating	Reason for rating
Oncorhynchus mykiss	Rainbow trout	SR	Nom	98.0%	96 h	NR	Cholinesterase inhibition; muscarinic cholinergic receptor number	40 d	--------	--------	Beauvais et al. 2000	LL	2,5
Oncorhynchus mykiss	Rainbow trout	FT	Meas	Analytical	28 d	15-17	Weight	1-3 g	--------	--------	Bresch 1991	LR	5
Oncorhynchus mykiss	Rainbow trout	SR	Nom	98.0%	96 h	15	Swimming behavior	Juvenile	--------	--------	Brewer et al. 2001	LL	2,5,6
Oncorhynchus mykiss	Rainbow trout	SR	Nom	98.0%	96 h	15	Acetylcholin-esterase inhibition	Juvenile	--------	--------	Brewer et al. 2001	LL	2,5,6
Oncorhynchus mykiss	Rainbow trout	S	Nom	89.0%	96 h	13	Mortality	1.2 g	90	--------	Johnson & Finley 1980	LL	4,6
Oncorhynchus mykiss	Rainbow Trout	S	Nom	91%	96 h	13-18	Mortality	3-7 cm	400	--------	Beliles 1965	RL	6
Oncorhynchus mykiss	Rainbow Trout	S	Nom	99.8%	96 h	14	Mortality	6 cm, 1.5g	>100,000	--------	Grade 1993	LR	5
Oncorhynchus tshawytscha	Chinook salmon	SR	Nom	Technical	96 h	10	Mortality	Eyed eggs	545,000	--------	Viant et al. 2006	RL	6
Oncorhynchus tshawytscha	Chinook salmon	SR	Nom	Technical	96 h	10	Mortality	Alevins	29,500	--------	Viant et al. 2006	RL	6

Species	Common identifier	Test type	Meas/ Nom	Chemical grade	Duration	Temp (^oC)	Endpoint	Age/size	LC/EC_{50} (µg/L)	MATC (µg/L)	Reference	Rating	Reason for rating
Oncorhynchus tshawytscha	Chinook salmon	SR	Nom	Technical	96 h	10	Phospho-creatine levels	Eyed eggs	--------	70,700	Viant et al. 2006	RL	2,6
Oreochromis niloticus x Mossambicus albina	Red tilapia	SR	Nom	97.5%	24 h	22	Mortality	4.27 g	6,000	--------	Palacio et al. 2002	LL	3,6
Oreochromis niloticus x Mossambicus albina	Red tilapia	SR	Nom	97.5%	48 h	22	Mortality	4.27 g	5,650	--------	Palacio et al. 2002	LL	3,6
Oreochromis niloticus x Mossambicus albina	Red tilapia	SR	Nom	97.5%	72 h	22	Mortality	4.27 g	4,360	--------	Palacio et al. 2002	LL	3,6
Oreochromis niloticus x Mossambicus albina	Red tilapia	SR	Nom	97.5%	96 h	22	Mortality	4.27 g	3,850	--------	Palacio et al. 2002	LL	3,6
Oryzias latipes	Japanese medaka	S	Nom	99.0%	96 h	NR	Total hatch	1-d embryos	--------	19,300	Hamm & Hinton 2000	LL	3,6
Oryzias latipes	Japanese medaka	S	Nom	99.0%	96 h	NR	Total hatch	3-d embryos	--------	19,300	Hamm & Hinton 2000	LL	3,6
Oryzias latipes	Japanese medaka	S	Nom	99.0%	8 d	NR	Total hatch	1-d embryos	--------	14,900	Hamm & Hinton 2000	LL	3,6
Oryzias latipes	Japanese medaka	S	Nom	99.0%	6 d	NR	Total hatch	3-d embryos	--------	19,300	Hamm & Hinton 2000	LL	3,6

Species	Common identifier	Test type	Meas/ Nom	Chemical grade	Duration	Temp (°C)	Endpoint	Age/size	LC/EC_{50} (µg/L)	MATC (µg/L)	Reference	Rating	Reason for rating
Oryzias latipes	Japanese medaka	S	Nom	99.0%	96 h	NR	Mean day of hatch	3-d embryos	--------	19,300	Hamm & Hinton 2000	LL	3,6
Oryzias latipes	Japanese medaka	S	Nom	99.0%	96 h	NR	Total length of larvae	1-d embryos	--------	2,200	Hamm & Hinton 2000	LL	3,6
Oryzias latipes	Japanese medaka	S	Nom	99.0%	96 h	NR	Total length of larvae	3-d embryos	--------	2,200	Hamm & Hinton 2000	LL	3,6
Oryzias latipes	Japanese medaka	S	Nom	99.0%	96 h	NR	Total length of larvae	5-d embryos	--------	2,200	Hamm & Hinton 2000	LL	3,6
Oryzias latipes	Japanese medaka	S	Nom	99.0%	8 d	NR	Total length of larvae	1-d embryos	--------	2,200	Hamm & Hinton 2000	LL	3,6
Oryzias latipes	Japanese medaka	S	Nom	99.0%	6 d	NR	Total length of larvae	3-d embryos	--------	2,200	Hamm & Hinton 2000	LL	3,6
Oryzias latipes	Japanese medaka	------	------	Technical	48 h	------	Mortality	------	5,300	--------	Nishiuki & Hashimoto 1967	LL	6
Paratya compressa improvisa	Shrimp	S	Nom	98-99 %	96 h	22	Mortality	4 wk	2.33	--------	Shigehisa & Shiraishi 1998	LL	4,6
Pimephales promelas	Fathead minnow	SR	Nom	99.0%	7 d	25	Biomass	< 24 h	1,176 (IC25)	--------	Dwyer et al. 2005	RL	6
Pimephales promelas	Fathead minnow	FT	Meas	88.2%	32 d	NR	Growth	< 24 h embryos	--------	25	Norberg-King 1989	RL	4,6

Species	Common identifier	Test type	Meas/ Nom	Chemical grade	Duration	Temp (°C)	Endpoint	Age/size	LC/EC_{50} (µg/L)	MATC (µg/L)	Reference	Rating	Reason for rating
Pimephales promelas	Fathead minnow	SR	Meas	88.2%	7 d	NR	Growth	< 24 h larvae	--------	251	Norberg-King 1989	RL	4,6
Pimephales promelas	Fathead minnow	FT	Meas	88.2%	7 d	NR	Growth	< 24 h larvae	--------	210	Norberg-King 1989	RL	4,6
Pimephales promelas	Fathead minnow	FT	Meas	88.2%	7 d	NR	Growth	< 24 h larvae	--------	122	Norberg-King 1989	RL	46
Poecilia reticulata	Guppy	SR	Nom	98.0%	96 h	20-22	Mortality	Adult females	800	--------	Keizer et al. 1991	LL	4,6
Pteronarcys californica	Insect	S	Nom	89.0%	96 h	15	Mortality	Second year class	25	--------	Johnson & Finley 1980	LL	4,6
Pteronarcys californica	Insect	S	Nom	Technical	24 h	15.5	Mortality	30-35 mm	155	--------	Sanders & Cope 1968	LL	4,6
Pteronarcys californica	Insect	S	Nom	Technical	48 h	15.5	Mortality	30-35 mm	60	--------	Sanders & Cope 1968	LL	4,6
Pteronarcys californica	Insect	S	Nom	Technical	96 h	15.5	Mortality	30-35 mm	25	--------	Sanders & Cope 1968	LL	4,6
Rana clamitans	Green frog	SR	Nom	50.0%	96 h	18.1	Hatching success	Embryo	--------	15.8	Harris et al. 1998	LL	1,6
Salvelinus namaycush	Brook trout	S	Nom	92.0%	96 h	12	Mortality	3.2 g	602	--------	Johnson & Finley 1980	LL	4,6

Species	Common identifier	Test type	Meas/ Nom	Chemical grade	Duration	Temp (°C)	Endpoint	Age/size	LC/EC_{50} (µg/L)	MATC (µg/L)	Reference	Rating	Reason for rating
Selenastrum Capricornutum	Green algae	S	Meas	87.7%	7 d	24	Mean standing crop, cells/mL	6-8 d old culture	--------	NOEC < 60	Hughes 1988	LR	5
Silurus glanis	European catfish	S	Nom	63%	96 h	16	Mortality	12-14 g, 10-12 cm	4.14	--------	Koprucu et al. 2006	LR	1,3
Simocephalus serrulatus	Cladoceran	S	Nom	89.0%	48 h	15	Immobility	1st instar	Test 1: 1.4 Test 2: 1.8	--------	Johnson & Finley 1980	LL	4,6

Reasons for exclusion

1. Chemical grade
2. Endpoint not linked to population effects
3. Family not in N. America
4. Control response
5. No toxicity value calculated
6. Low reliability score

Table 9. Synergistic interactions between diazinon and other pesticides.

Species	Pesticide 1 (at EC_{50} concentration)	Synergist (concentration)	SR (K)[1]	Reference
Chironomus tentans	Diazinon	Cyanazine (200 µ/L)	2.2	Lydy & Austin 2004
Hyalella azteca	Diazinon	Atrazine (10 µ/L)	1.0	Anderson & Lydy 2002
Hyalella azteca	Diazinon	Atrazine (40 µ/L)	1.0	Anderson & Lydy 2002
Hyalella azteca	Diazinon	Atrazine (80 µ/L)	2.0	Anderson & Lydy 2002
Hyalella azteca	Diazinon	Atrazine (200 µ/L)	3.0	Anderson & Lydy 2002
Chironomus tentans	Diazinon	Atrazine (10 µ/L)	1.0	Belden & Lydy 2000
Chironomus tentans	Diazinon	Atrazine (40 µ/L)	1.81	Belden & Lydy 2000
Chironomus tentans	Diazinon	Atrazine (80 µ/L)	2.11	Belden & Lydy 2000
Chironomus tentans	Diazinon	Atrazine (200 µ/L))	2.71	Belden & Lydy 2000

[1] SR = synergistic ratio, which is equivalent to K = interaction coefficient; each is the ratio of the EC_{50} of the pesticide alone to the EC_{50} of the pesticide in the presence of a non-toxic concentration of the synergist.

Table 10. Predicted LC_{50} values for threatened or endangered species

Species	Common Name	Family	LC_{50} (µg/L)	Surrogate
Gila elegans	Bonytail chub	Cyprinidae	2408	*Pimephales promelas*
Ptychocheilus lucius	Colorado squawfish	Cyprinidae	2750	*Pimephales promelas*
Oncorhynchus clarki	Cutthroat trout	Salmonidae	1205	*Salvelinus fontinalis*
Oncorhynchus kisutch	Coho salmon	Salmonidae	1382	*Salvelinus fontinalis*
Oncorhynchus mykiss	Steelhead	Salmonidae	730	*Salvelinus fontinalis*

Appendix A

Ecosystem and Field Study Supplemental Information

Amato JR, Mount DI, Durhan EJ, Lukasewycz MT, Ankley GT, Robert ED. 1992. An example of the identification of diazinon as a primary toxicant in an effluent. *Environmental Toxicology and Chemistry* 11: 209-216.
A toxicity identification evaluation (TIE) was run by performing separate tests with *Pimephales promelas* and *Ceriodaphnia dubia* using municipal effluent. Diazinon concentrations of 0.21-1.31 µg/L (impact of contaminants in most about 0.35 µg/L) were measured via gas chromatography analysis and correlated well with the toxicity of each sample.

Anderson BS, Hunt JW, Phillips BM, Nicely PA, de Vlaming V, Connor V, Richard N, Tjeerdema RS. 2003. Integrated assessment of the impacts of agricultural drainwater in the Salinas River (California, USA). *Environmental Pollution* 124:523-532.
Impact of contaminants in agricultural drainwater were examined by measuring macroinvertebrate abundances in river bottoms, toxicity tests of river water to *Ceriodaphnia dubia,* and measured pesticide concentrations. Diazinon concentrations of 3.0-0.2 µg/L correlated to low macroinvertebrate abundance (not significant) and toxicity to *Ceriodaphnia dubia.*

Bailey HC, Deanovic L, Reyes E, Kimball T, Larson K, Cortright K, Connor V, Hinton DE. 2000. Diazinon and chlorpyrifos in urban waterways in Northern California, USA. *Environmental Toxicology and Chemistry* 19:82-87.
Concentrations of diazinon were measured using enzyme-linked immunosorbent assays (ELISA) in urban streams of Sacramento and Stockton, CA, in 1994 and 1995. Most samples were collected between October and May and associated with storm water runoff events. Diazinon concentrations ranged from below detection limit to 1.5 µg/L, with a median of 0.21 µg/L (n=230 samples). TIEs indicated diazinon and chlorpyrifos as major players in observed toxicity to *Ceriodaphnia dubia*.

Burkhard L, Jenson JJ. 1993. Identification of ammonia, chlorine, and diazinon as toxicants in a municipal effluent. *Archives of Environmental Contamination and Toxicology* 25:506-515.
A toxicity identification evaluation (TIE) was run by performing separate tests with *Pimephales promelas* and *Ceriodaphnia dubia* using municipal effluent over an 8-month period. Ammonia, chlorine and diazinon were identified as the primary cause of toxicity. Toxicity occurred when the diazinon concentrations were 0.054 - 1.68 µg/L.

De Vlaming V, DiGiorgio C, Fong S, Deanovic LA, de la Paz Carpio-Obeso M, Miller JL, Miller MJ, Richard NJ. 2004. Irrigation runoff insecticide pollution of rivers in the Imperial Valley, California (USA). *Environmental Pollution* 132:213-229.
Studies on water quality of the Alamo River and New River conducted between 1993 and 2002 revealed widespread toxicity due to the organophosphate pesticides chlorpyrifos and diazinon from agricultural applications. Diazinon was detected at 0.1-2.8 toxic units (1 toxic unit = 0.4 µg/L) in the Alamo River, and was present in every toxic sample from the New River.

Hunt JW, Anderson BS, Phillips BM, Nicely PN, Tjeerdema RS, Puckett HM, Stephenson M, Worcester K, de Vlaming V. 2002. Ambient Toxicity due to chlorpyrifos and diazinon in a Central California coastal watershed. *Environmental Monitoring and Assessment* 82:83-112.
In all samples where diazinon was detected there was no survival of *Ceriodaphnia dubia*. The highest concentration of diazinon was 5.2 µg/L and the average concentration detected was 0.87 µg/L. Other evidence indicated organophosphates as cause of toxicity. NOTE: This study was also cited in Mixtures sections of Chlorpyrifos and Diazinon criteria reports.

Kuivila KM, Foe CG. 1995. Concentrations, transport and biological effects of dormant spray pesticides in the San Francisco Estuary, California. *Environmental Toxicology and Chemistry* 14:1141-1150.
This study detected distinct pulses of pesticides, including diazinon in the San Joaquin and Sacramento rivers following rainfall. Sacramento River water at Rio Vista was acutely toxic to *Ceriodaphnia dubia* for 3 consecutive days and San Joaquin River water at Vernalis for 12 consecutive days. Diazinon concentrations were high enough for most, but not all, of the observed toxicity. Measured concentrations in the Sacramento and the San Joaquin rivers were 0.037-0.281 µg/L, and 0.043-1.07 µg/L diazinon, respectively.

Teh SJ, Deng DF, Werner I, Teh FC, Hung SSO. 2005. Sublethal toxicity of orchard stormwater runoff in Sacramento splittail (*Pogonichthys macrolepidotus*) larvae. *Marine Environmental Research* 59:203-216.
This study measured survival, growth, histopathological abnormalities and stress protein expression (hsp60, hsp70) in larval fish (Sacramento splittail) exposed for 96 h to storm water runoff samples collected within a prune orchard after dormant spray application of diazinon. Fish were moved to clean water after 96 h exposures and maintained for 3 months to evaluate delayed effects. No significant mortality occurred after 96 h exposure to runoff containing a maximum concentration of 210.4 µg/L diazinon, but body weight and condition factor after 3 months were lower in fish exposed to runoff containing 210.4 µg/L diazinon than in control animals. Stress proteins were significantly above control levels in exposed fish. Histopathological abnormalities were seen one week after exposure, but not after the 3 month recovery period.

Werner I, Deanovic LA, Connor V, de Vlaming V, Bailey HC, Hinton DE. 2000. Insecticide-caused toxicity to *Ceriodaphnia dubia* (Cladocera) in the Sacramento-San Joaquin River delta, California, USA. *Environmental Toxicology and Chemistry* 19:215-227.
In this 1993-1995 monitoring study, samples were collected monthly from 24 sites in the Sacramento-San Joaquin River delta. Diazinon was identified as a primary toxicant primarily during fall and winter months, and measured concentrations in toxic samples ranged from 0.125 to 0.422 µg/L.

Werner I, Deanovic LA, Hinton DE, Henderson JD, Oliveira GH, Wilson BW, Osterli P, Krueger W, Wallender WW, Oliver MN, Zalom FG. 2002. Toxicity of

stormwater runoff after dormant spray application of diazinon and esfenvalerate (Asana) in a French Prune Orchard, Glenn County, California. ***Bulletin of Environmental Contamination and Toxicology*** **68:29-36.**
In this study, larval fish (fathead minnows, Sacramento splittail) and water fleas (*Ceriodaphnia dubia*) were exposed to storm water runoff collected in an orchard after application of dormant spray insecticides, diazinon and esfenvalerate. Diazinon concentrations measured in orchard runoff were 118-210 µg/L. Runoff from one of the four diazinon sprayed areas was toxic to minnow larvae. Inexplicably, a non-sprayed area, which had 15.6 µg/L diazinon, exhibited that same percent mortality of minnows, about 25% mortality. (Similar study to Werner *et al*. (2004) discussed in mesocosm data section.)

Appendix B

Comparison of acute data used by USEPA, CDFG, and in this report for diazinon water quality criteria

Comparison of the toxicity values used by USEPA, California Department of Fish and Game (CDFG)[1] and UC Davis (UCD) for derivation of water quality criteria for diazinon.

Objective and overview

Data used by three agencies to calculate acute water quality criteria for diazinon were tabulated for side by side comparison (Table B-1). Studies excluded by UCD, but included in either the CDFG or EPA criteria derivation were further examined to identify the reasons they were excluded. This information, described in Part I of the text below, was used to generalize the differences in the screening methods of each agency. In Part II, the reasons EPA and CDFG excluded studies were summarized as another way to compare the data quality requirements of the three agencies. Part III of the text describes a comparison of criteria derived by the Burr Type III and log-triangular distributions. Both calculations were performed using the data sets from the three agencies, plus a hypothetical combination data set, as examples of how the presence of the excluded values affects the final criteria. The resulting criteria are presented in Table B-2. Tables B-3 and B-4 display the values used for the calculations, and the values are plotted in Figure B-1. A graph of the fit of the distributions is included in Figure B-2. Part IV is a comparison of the values used to calculate the ACR for the chronic criterion. For ease of reading all of the tables are presented at the end of this appendix.

Brief summary of comparison

The UCD criteria were very similar to those in the EPA criteria report (see Table B-2). The data selection of UCD produced a data set with fewer and lower values than the EPA data set, but the Burr Type III distribution resulted in a nearly equivalent acute criterion to that of the EPA (0.18 and 0.17 µg/L for UCD and EPA, respectively).

<u>Summary of data selection differences:</u> Broadly speaking, EPA and CDFG requirements for acceptable data were similar to those of UCD. For example, UCD, EPA and CDFG all exclude studies that do not report acceptable control survival. UCD selection was more stringent on the chemical grade used and not using values reported as greater than (>) or less than (<) a given concentration, but these accounted for fewer unused data than the acceptability of the control description.

The most important factor that affected data selection was the reporting of or acceptability of control survival (see Part I). The UCD rating system was most stringent, favoring the use of complete study reports that contained control descriptions and responses, experimental concentrations, etc. The other agencies accepted studies because of the reputation of the laboratory or citation of ASTM methods, even if measured parameters were not reported. This factor had a noticeable effect, resulting in smaller data sets for UCD and CDFG, which in turn produced lower criteria.

Additionally, some of the lowest values in the UCD report were not in the EPA or CDFG report for various reasons (see Part III). This also contributed to decreasing some of the example acute criteria derived using the UCD data set.

[1] The CDFG recommended criteria were recalculated (CVRWQCB 2005) after a problem with the value of 0.2 µg/L for *Gammarus fasciatus* was identified (Hall & Anderson 2005). In this review, that value was also omitted from the CDFG data set.

Summary of the influence of the statistical distribution: The Burr Type III distribution resulted in both higher and lower criteria in different instances. The log-triangular distribution gave more similar results to the Burr III when the Burr III was fit to a lower subset of the data.

PART I

Reasons studies were excluded by UCD, while the values were used by CDFG and/or EPA

UCD excluded some of the acute values that were used in CDFG and EPA diazinon criteria reports. This section summarizes the main reasons those studies were excluded by UCD.

First, the number of acute studies used by agency was counted. In this count, if multiple species were tested in the same study, they were counted as separate studies. The EPA report used the most studies (36), while CDFG (29) and UCD (22) used less studies.

There were 29 values used by CDFG or EPA that were excluded by UCD. The reasons UCD did not use the values from those studies are listed bellow:

Number of times a parameter was used to exclude a value, followed by the reason:

- (19) control survival not reported or acceptable*
- (4) chemical grade was lower than 80% pure or not reported & control or control survival not reported or acceptable
- (1) no toxicity values calculated & chemical grade was lower than 80% pure
- (4) lack of other parameters that had less weight in rating system (control not described, water quality parameters not reported, concentrations used not reported, no standard method, temp not held to ± 1 ºC, organism source not reported)
- (1) was not obtained because it did not have a calculated value and the study was not in the peer reviewed literature, OPP or ECOTOX data bases. (Vial 1990, *Daphnia magna* LC_{50} > 2.6 µg/L)

Judging by the list above and comparing to criteria of the other agencies in Part II, UCD selection was more stringent on the chemical grade used and not using values reported as > or <. More importantly, there was some difference in evaluation of an acceptable description of controls as described below.

*These 19 values came from about nine studies in which control survival was not reported or acceptable. Both CDFG and EPA also state that unreported or unacceptable control response was a reason for excluding studies (see Part II). However, these studies were used in their documents. EPA used all nine studies, while CDFG used only four of the nine. Of the studies CDFG used, two were Sanders and Cope (1966) and Keizer *et al.* (1991), which CDFG states had 100% control survival, but this information was not found in these studies. In the CDFG report personal communication was also cited for Ankley *et al.* (1991). UCD contacted the author who said they may or may not still have this record. The information was not received then or after a later follow up. CDFG also used Mayer and Ellersieck (1986), for which they describe the reference and the reason they use the studies below.

Note about Mayer and Ellersieck (1986), Johnson and Finley (1980)
Description from CDFG (Siepmann & Finlayson 2000) criteria report:
"Mayer and Ellersieck (1986) - In 1986, a study was conducted by the Fish and Wildlife Service to generate static acute toxicity test data for 410 chemicals with 66 freshwater species. All tests were performed at the Columbia National Fisheries Research Laboratory and its field laboratories between 1965 to 1984. The studies on technical grade diazinon (97%) were conducted with eight species. The tests were generally in compliance with ASTM (1980) and EPA (1975) standards. At least five concentrations of diazinon were tested. Two replicates per concentration were tested. Depending on the species, water quality parameters during the tests were as follows: temperature of 2.0 ºC to 29 ºC; pH of 6.0 to 9.0; and hardness of 44 mg/L to 272 mg/L. Control survival, dissolved oxygen, and measurement of diazinon concentrations were not discussed…. Although information about some important test characteristics could not be obtained, most of these data were accepted because of the use of ASTM guidelines and the reputation of the laboratory…."

The Mayer & Ellersieck (1986) report contains most of the data reported in Johnson and Finley (1980). Mayer Ellersieck (1986) says to assume all tests meet cited ASTM and EPA methods. Johnson and Finley (1980) describe methods in detail, but not use of controls. Values from Sanders and Cope (1968), Sanders (1969), and Macek *et al.* (1969) are also repeated in these volumes. These references are also the source of the erroneous value of 0.2 µg/L for *Gammarus fasciatus.*

From the UCD methods perspective, to be fair and impartial in rating the quality of all studies, such assumptions should be avoided and evaluation should be based only on information reported. It was also preferable that original study reports be used. This helps to avoid errors, as in the value for *G. fasciatus*.

PART II

The data screening methods in the EPA and CDFG criteria reports were reviewed here to be able to compare them with UCD methods. Overall, the reasons EPA and CDFG provided for excluding studies were similar to those of UCD.

CDFG exclusion of studies
The CDFG diazinon and chlorpyrifos criteria document contains an appendix that summarizes and briefly discusses why studies were used or not used, including both saltwater and freshwater data. The 16 studies rejected often had more than one of the reasons below.

Number of times a parameter was used to exclude a value, followed by the reason:

- (8) active ingredient too low or not reported
- (6) control survival too low or not reported
- (5) mortality range inadequate or not reported
- a few studies also cited

-dissolved oxygen low or not reported
-no toxicity values calculated
-inadequate duration
-inappropriate dilution water
-hardness not reported

EPA exclusion of studies
EPA documents contain an unused data section in which a reason for exclusion of a study is followed by citations of studies omitted for that reason. Freshwater and saltwater data were mixed in this section that contains 158 excluded studies.

Number of times a parameter was used to exclude a value, followed by the reason:

- (43) conducted with species that are not resident in North America
- (16) data were compiled from other sources
- (42) diazinon was a component of a drilling mud, effluent, mixture, sediment or sludge
- (11) either the test procedures, test material, or dilution water was not adequately described
- (3) the tests were conducted in distilled or deionized water without addition of appropriate salts or were conducted in chlorinated or "tap" water,
- (1) concentration of a water-miscible solvent used to prepare the test solution exceeded 0.5 mL/L
- (10) results were not adequately described or could not be interpreted
- (4) tests conducted without controls, with unacceptable control survival, or with too few tests
- (1) organisms preconditioned to organophosphorus chemicals
- (27) experimental model was plasma, enzymes, tissue, or cell cultures

Additionally, examination of data tables and species mean acute values show that acceptable values from static tests with fish were not used if acceptable values were available from flow through tests.

PART III

Burr Type III and log-triangular criteria calculation with all three data sets

Methods
To examine how the different values selected may influence the final criteria calculation, the log-triangular method and Burr Type III method were used to calculate criteria for each agency's data set. To address the criticism that criteria by UCD method were lower simply because it excluded higher values contained mostly in Mayer & Ellersieck (1986), a hypothetical combination data set was created by adding excluded values back into the UCD data set. This was done by starting with the UCD data set (as it is in Table B-3 or B-4) and adding in any species values from EPA data where UCD had none, or from CFDG if EPA had none.

For the log-triangular calculation, Genus Mean Acute Values (GMAVs) were used following EPA (1985) methods. For the Burr Type III calculation Species Mean Acute Values (SMAVs) were used. SMAVs were calculated as the geometric mean of all LC_{50} values for the same species. Then, GMAVs were calculated as the geometric mean of all species values in the same genus. For the Burr Type III calculation the chosen percentile and confidence level used was the same as in UCD criteria reports: the 5th percentile at 50% confidence. These results are presented in Tables B-3 and B-4. For the log-triangular calculation, the lowest 4 values are repeated at the bottom of the table for easy comparison as those values are weighted heavily in this calculation.

Plots of the distributions fit to the UCD data set were included as Figure B-2. The EPA log-triangular plot was graphed following the procedure in USEPA (1985) and the Burr Type III distribution was constructed using the fit parameters obtained from the BurrliOZ software (CSIRO. 2001).

For the Burr Type III distribution, the EPA, CDFG, and hypothetical data sets did not produce a 5th percentile value (values were calculated as 0.000000, 0.027 and 0.020 µg/L, respectively, and the fitted distribution did not pass the fit test). This was likely due to the multimodality of these data (Figure B-1 and B-2). Also included in Table B-4 is the calculation performed with the lower subset of values as suggested in the UCD methodology for data that is multimodal. The visual break was below 400 µg/L and separated the phyla Arthropoda from the other phyla. Chordates (fish) and a few other phyla had higher LC_{50} values. *Rana clamitans,* which did not have an explicit value and was reported as > 50 µg/L, was grouped with the other chordates for this calculation. Also, the CDFG values for *Lepomis macrochirus* (272 µg/L) and *Oncorhynchus mykiss* (90 µg/L) did not fit clearly into one subset and were grouped with the other chordates.

When the UCD and CDFG data set were split, they contained less than eight values. Following UCD methodology, data sets with eight or fewer values were fit to a Log-Logistic distribution. This was done using the ETX 1.3 software (Aldenberg 1993).

Results

Using these different data sets and methods, most of the resulting criteria equated to about 0.2 µg/L (Table B-2). Use of the log-triangular distribution with the UCD data set and the Burr Type III distribution with the CDFG data set resulted in lower criteria closer to 0.1 µg/L. This could have been because these agency reports had lower values and a smaller number of values.

<u>Influential values</u>

The UCD data set did contain some of the lowest values at the sensitive end, which seemed to be very influential in the log-triangular distribution. Sources of the low GMAVs not included in the EPA report included one study from CDFG (*Neomysis mercedis*, CDFG 1992) and one published after the EPA 2005 criteria report (*Procloeon sp*., Anderson *et al.* 2006). For the genus *Daphnia (magna* and *pulex*) the GMAV used were higher in EPA and CDFG reports than in the UCD report, 1.06 or 0.902 µg/L vs. 0.52 µg/L, respectively. The values used by EPA and CDFG did not rate high enough to be used by UCD, while UCD used the value from Surprenant (1988), which was not used by EPA (although it is an unpublished report, typical of data used to meet registration requirements) or CDFG, perhaps because the organisms were fed during the acute test. Also, UCD used a value for *Hyalella azteca* (Anderson and Lydy 2002) that was published after the CDFG 2000 report and that EPA did not use.

<u>Log-Triangular Distribution, Table B-3</u>

Criteria resulting from the log triangular calculation for the UCD data set were lower than those resulting from the EPA, CDFG, or hypothetical data sets, which were more similar. When the excluded values were added back to the UCD data set (exemplified in the hypothetical data set) the criteria doubles, from 0.09 to 0.20 μg/L. Two reasons were found to explain the lower criterion from the UCD data set: 1) the lower values in the data sets, and 2) there were fewer values in the data set. However, the criterion from the CDFG data set, which had only one more value (14 values), was closer to the EPA criterion (derived from 20 values). The two lowest values in the UCD data set may be driving the difference, setting the resulting criterion apart from the others.

Burr Type III Distribution, Table B-4
The bimodal data distribution makes it difficult to derive a number with the whole EPA, hypothetical, and CDFG data sets using the Burr Type III distribution. Surprisingly, the criterion derived from the lower EPA subset (0.21 μg/L) using the Burr Type III distribution was close to the criterion reported by EPA (0.17 μg/L). The criterion derived using the entire UCD data set (0.18 μg/L) was similar to that of the EPA (0.20 μg/L). The criteria results of the Burr Type III distribution approach (including the log-logistic distribution) were higher compared to the log-triangular results for the same data set in two of four cases, particularly for the UCD data set (0.18 vs. 0.09 μg/L). For the hypothetical data set, the criteria were equivalent (0.20 μg/L), and for the CDFG data set it was lower with the log-triangular than Burr Type III (0.11 and 0.16 μg/L, respectively).

The purpose of the hypothetical data set was to examine the effect of the exclusion of values from Mayer and Ellersieck (1986) by UCD. The values were added back to the hypothetical data set to see if they would alter the criteria significantly. Using the Burr Type III distribution the criterion from the UCD dataset (0.18 μg/L) was close to that from hypothetical data set (0.20 μg/L), suggesting these values were not very influential. This comparison could not be made exactly because the Burr Type III distribution could only be used with the lower subset of the values in the hypothetical data set. However, the criteria from the log-triangular distribution were the same for both data sets (0.20 μg/L.)

The Burr Type III distribution fit the entire UCD data set, but this data set was also split based on the bimodal distribution for the purpose of comparison. Fitting the log-logistic distribution to the lower subset provided similar results to the log-triangular analysis (0.1 and 0.09 μg/L, respectively).

Summary
Overall, criteria from different agencies did not vary widely and were comparable, especially those of EPA and UCD. This comparison demonstrates that the UCD data set yielded a lower criterion using the log-triangular distribution, but the Burr Type III distribution yielded a nearly equivalent criterion (0.18 μg/L) to the EPA criterion (0.17 μg/L). The Burr Type III distribution does not always provide higher criteria, as this was not the case in the CDFG data set or the chlorpyrifos report.

The main factors altering criteria:

1) inclusion of lower data, by UCD for various reasons;
2) the use of less data by UCD (and CDFG), see part I for details;
3) the distribution, with the Burr Type III distribution resulting in both higher and lower criteria in different instances.

As a final point of interest for the diazinon data set, the log-triangular distribution gave more similar results to the Burr Type III distribution when it was fit to only the lower subset of the data.

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Table B-1. Comparison of Acceptable Acute Values for Diazinon Criteria by Agency.
Y- indicates agency used that value. Where disputed, the value used is shown. Only studies that at least one agency used are included.

Species, Common identifier	LC/EC_{50} (µg/L)	EPA 2005	CDFG 2000	UCD 2007	Reference	UCD Rating: Reason for Exclusion (see end of table for key)	Comments
Brachionus calyciflorus, Rotifer	29,220		Y		Fernandez-Casalderrey *et al.* 1992	29220 was a preliminary LC_{50}, w/o test details (Rating for other values in study - RL: SM, Conc NR, DO, C, % Solvent NR)	
Carassius auratus, Goldfish	9,000	Y			Beliles 1965	RL: 7, SM, Conc NM, % solvent NR, Temp not held ± 1 ºC, H, A, DO, C, pH, P,	
Ceriodaphnia dubia, Cladoceran	0.5	Y	Y		Ankley *et al.* 1991	RN: 4, 7, 8 Conc NR, H, A, DO, C, Ph, P, >0.05% solvent	CDFG: also cited pers comm
	0.58	Y			Bailey *et al.* 1997		EPA used 48h values (there were 4) WB and CDFG used 96h values (only 2)
	0.48	Y					
	0.26	Y					
	0.29	Y					
	0.32		Y	Y			
	0.35		Y	Y			
	0.33			Y	Bailey *et al.* 2000		
	0.38			Y	Bailey *et al.* 2001		
	0.33			Y			
	0.21			Y	Banks *et al.* 2005		
	0.45			Y	Banks *et al.* 2003		
	0.436		Y	Y	CDFG 1998, Test 122		
	0.47		Y	Y	CDFG 1992, Test 157		
	0.507		Y	Y	CDFG 1992, Test 163		
	0.57		Y		Norberg-King 1978	(Tests 1 & 3) LL: 8, SM, Conc NR, Fed, A, H, P	EPA: Acceptable: h Memorandum, Not in OPP data base or Diazinon IRED
	0.35	Y				(Tests 4, 5, 8-14) LL: 8 SM, Conc NR, Fed, DO, Inappropriate dilution water, A, C, H, pH, P	

Species, Common identifier	LC/EC50 (µg/L)	EPA 2005	CDFG 2000	UCD 2007	Reference	UCD Rating: Reason for Exclusion (see end of table for key)	Comments
	0.35	Y				See above	
	0.25	Y				See above	
	0.33	Y				See above	
	0.35	Y				See above	
	0.59	Y				See above	
	0.43	Y				See above	
	0.35	Y				See above	
	0.36	Y				See above	
Chironomus tentans, Insect	10.7	Y		Y	Ankley and Collyard 1995		
Danio rerio, Zebrafish	8,000	Y	Y		Keizer *et al.* 1991	LN: 4, 7, 8, Conc. NR, fed NR, DO, A, C, H, # per replicate NR	
Daphnia magna, Cladoceran	0.8	Y	Y		Ankley *et al.* 1991	RN: 4, 7, 8 Conc NR, H, A, DO, C, Ph, P, >0.05% solvent	CDFG: also cited pers comm
	1.5	Y			Dortland 1980	LN: 4, 7, SM Conc NR, H, A, DO, C, pH,	
	0.52			Y	Surprenant 1988		
	>2.6		Y		Vial 1990	No value calculated, Not obtained	Not in OPP data base
	0.96	Y			Vilkas 1976	LL: 4, 7, 8, Conc NR,	
Daphnia pulex, Cladoceran	0.65	Y	Y		Ankley *et al.* 1991	RN: 4, 7, 8 Conc NR, H, A, DO, C, Ph, P, >0.05% solvent	CDFG: also cited pers comm
	0.9	Y	Y		Cope 1965; Sanders and Cope 1966	N: 1,4, 8, SM	CDFG: Sanders and Cope 1966 " control survival was 100%'
	0.8	Y	Y		Johnson and Finley 1980; Mayer and Ellersieck 1986	LL: 4, 7*	CDFG: "control survival acceptable in all tests", also cited pers. comm
Dugesia tigrina, Planaria	11,640	Y			Phipps 1988	N: 1,7,8	Not in OPP data base or Diazinon IRED
Gammarus fasciatus, Amphipod	2.04	Y			Johnson and Finley 1980; Mayer and Ellersieck 1986	LL: 4,7 *	CDFG originally use the value of 0.204. See footnote 1, p C2
Gammarus pseudolimnaeus, Amphipod	16.82	Y		Y	Hall and Anderson 2004		

Species, Common identifier	LC/EC_{50} (µg/L)	EPA 2005	CDFG 2000	UCD 2007	Reference	UCD Rating: Reason for Exclusion (see end of table for key)	Comments
Gillia altilis, Snail	11,000	Y			Robertson and Mazzella 1989	LL: 4,7, SM, Conc NM, DO, C, P, Fed NR, % solvent too high, Temp not held ± 1 ºC, Org. possibly prior contaminant exposure	
Hyalella azteca, Amphipod	6.51	Y			Ankley and Collyard 1995	LR: 4	
	4.3			Y	Anderson & Lydy 2002		
Jordanella floridae, Flagfish	1,500	Y	Y	Y	Allison and Hermanutz 1977		CDFG: also cited pers comm.
	1,800	Y	Y	Y			
Lepomis macrochirus, Bluegill	480	Y		Y	Allison and Hermanutz 1977		CDFG: insufficient number of test organisms used
	440	Y	Y	Y			CDFG: also cited pers comm
	168		Y		Johnson and Finley 1980; Mayer and Ellersieck 1986	LL:4, 7*	CDFG: "control survival acceptable in all tests", also cited pers. comm EPA: Acceptable:h
Lumbriculus variegatus, Oligochaete worm	6,160	Y			Ankley and Collyard 1995	LL: 4,7, SM, Conc NR, % solvent too high	
	9,980	Y			Phipps 1988	N: 1,7,8	Not in OPP data base or Diazinon IRED
Neomysis mercedis, Mysid	3.57		Y	Y	CDFG 1992, Test 162		
	4.82		Y	Y	CDFG 1992, Test 168		
Oncorhynchus clarki, Cutthroat trout	1,700	Y	Y		Johnson and Finley 1980; Mayer and Ellersieck 1986	LL: 4,7*	CDFG: "control survival acceptable in all tests", also cited pers. comm
	2,760	Y	Y		Mayer and Ellersieck 1986	LL: 4,7*	CDFG: "control survival acceptable in all tests", also cited pers. comm
Oncorhynchus mykiss, Rainbow trout	400	Y			Beliles 1965	RL: 7, SM, Conc NM, Temp not ± 1 ºC, H , A, DO, C, pH, P,	
	3,200	Y			Bathe *et al.* 1975a	N: 1,4, 8 SM	

Species, Common identifier	LC/EC_{50} (µg/L)	EPA 2005	CDFG 2000	UCD 2007	Reference	UCD Rating: Reason for Exclusion (see end of table for key)	Comments
	90	Y	Y		Cope 1965a; Johnson and Finley 1980; Mayer and Ellersieck 1986, Ciba-Geigy 1976	LL: 4,7 for Johnson and Finley 1980*, Cope 1965 LN: 4	CDFG: "control survival acceptable in all tests", also cited pers. comm
	1,350	Y			Meier *et al.* 1979; Dennis *et al.* 1980	LN: 4, SM, solvent % NR, Org. stage + source, Conc NR, DO, T pH	
Physa sp. Pond snail	4,441		4.41	Y	CDFG 1998b		report in mg/L. CDFG mistake
Pimephales promelas, Fathead minnow	6,600	Y	Y	Y	Allison and Hermanutz 1977		CDFG: also cited pers comm
	6,800	Y	Y	Y			
	10,000	Y	Y	Y			
	9,350	Y	Y	Y	Geiger/University of Wisconsin-Superior 1988		
	6,900	Y	Y	Y	Jarvinen and Tanner 1982		
Poecilia reticulata, Guppy	800	Y	Y		Keizer *et al.* 1991	LL: 4, 7 ,8, Conc. NR, fed NR, DO, A, C, H, # per replicate NR	CDFG: Control survival was 100%, but article only states 'meets EEC guidelines'
Pomacea paludosa, Apple snail	2,950	Y		Y	Call 1993		
	3,270	Y		Y			
	3,390	Y		Y			
Procloeon sp., Insect	1.53			Y	Anderson 2006		
	2.11			Y			
	1.77			Y			
Pteronarcys californica, Insect	25	Y	Y		Cope 1965a; Sanders and Cope 1968; Johnson and Finley 1980; Mayer and Ellersieck 1986	LL: 4,7 for Johnson and Finley 1980*; LL 4,7 for Sanders and Cope 1968	CDFG: "control survival acceptable in all tests", also cited pers. comm
Rana clamitans, Frog	>50	Y			Harris *et al.* 1998	LL: 1,6,7	
Salvelinus fontinalis, Brook trout	800	Y	Y	Y	Allison and Hermanutz 1977		CDFG: also cited pers comm.
	450	Y	Y	Y			

Species, Common identifier	LC/EC50 (µg/L)	EPA 2005	CDFG 2000	UCD 2007	Reference	UCD Rating: Reason for Exclusion (see end of table for key)	Comments
	1,050	Y	Y	Y			
Salvelinus namaycush, Lake trout	602	Y	Y		Johnson and Finley 1980; Mayer and Ellersieck 1986	LL: 4,7 for Johnson and Finley 1980*	CDFG:"control survival acceptable in all tests", also cited pers. comm
Simocephalus serrulatus, Cladoceran	1.8	Y	Y		Cope 1965a; Sanders and Cope 1966; Mayer and Ellersieck 1986	LL: 4,7 for Johnson and Finley 1980*; N: 4,1 for Sanders and Cope 1966	CDFG: Sanders and Cope 1966 " control survival was 100%'
	1.4	Y	Y		Sanders and Cope 1966; Johnson and Finley 1980; Mayer and Ellersieck 1986	LL: 4,7 for Johnson and Finley 1980*; N: 4,1 for Sanders and Cope 1966	CDFG: Sanders and Cope 1966 " control survival was 100%'
Total individual values (total number of 'Y's)	58	37	35				
Studies used (values for different species in the same reference counted separately)	36	29	23				

Please refer to an appropriate criteria document for full citations

* See text in Part I for discussion of why UCD did not use values in Johnson and Finley 1980 and Mayer and Ellersieck 1986

Codes for reasons for exclusion in the Table B-1.

This table includes all values used by any of the three agencies. Reports from all agencies mention many studies that were judged unacceptable that were not included in the reports. Because of the large number of these studies, they were not included in this table.

Y- indicates value was USED by agency

Acceptable: indicated values were ACCEPTABLE, BUT NOT USED by specified agency because more preferable data were available. Details are in the following list:

a. 96-h result available
b. Test with measured concentrations available
c. 48-h result available
d. More sensitive endpoint available
e. Non-standard temperature
f. More sensitive lifestage available
g. Flow-through test available
h. EPA 2005: a more sensitive study was available

Major reasons for studies rated UNACCEPTABLE by UCD only.
These studies were rated LR, RL, LL, RN, LN, N according to UCD methods (see Methodology, Chapter 3 for details):

1. Chemical grade was lower than 80% pure
2. Endpoint not linked to population effects
3. Family not in North America
4. Control response was not acceptable or not reported
5. Not a freshwater test
6. No toxicity value calculated
7. Low reliability score- based on reporting of many parameters including those listed just below
8. Control not described or not reported (i.e., solvent or water only)

For studies excluded only because of low reliability score (#7 from table above) more information was given with the following abbreviations:

NR- not reported
SM- no standard method
Conc NR- concentrations not reported
Conc NM- concentrations not measured (nominal)
Org- organism
Control desc. -control not described at all
DO - dissolved oxygen NR
H-hardness NR
A- alkalinity NR
C-conductivity NR
pH- pH NR
T- temperature NR
P-photoperiod NR
% solvent -carrier solvent percent not reported or too high, as indicated
Control Type NR- not reported whether control was solvent control or water only
Fed- organisms fed in acute test

Table B-2. Criteria comparison by data set and calculation methods.

Method of calculation	Criteria (μg/L) from each data set			
	EPA 2005	CDFG 2000	UCD 2007	Hypothetical Combination
Log-Triangular	0.17	0.16	0.090	0.20
Burr Type III/Log-logistic	0.21 [a,b]	0.11 [a,b]	0.18 [a]	0.20 [a,b]
Criterion from agency report	0.17	0.16	0.18 [a]	-

[a] Values would be rounded to 1 significant figure by UCD methods, but left here with 2 significant figures to show slight difference in calculation.
[b] Based on lower subset of invertebrates, because the entire data set could not be fit to a Burr Type III distribution.

Table B-3. Log-Triangular Calculation for Diazinon Genus Mean Acute Values.

	Diazinon Genus Mean Acute Values (µg/L)			
Genus species	**EPA 2005**	**CDFG 2000**	**UCD 2007**	**Hypothetical Combination**
Brachionus calyciflorus		29220		29220
Dugesia tigrina	11640			11640
Gillia altilis	11000			11000
Carrasius auratus	9000			9000
Danio rerio	8000	8000		8000
Lumbriculus variegatus	7841			7841
Pimephales promelas	7804	7804	7804	7804
Pomacea paludosa	3198		3198	3198
Jordanella floridae	1643	1643	1643	1643
Oncorhynchus clarki, mykiss	960.4	441		960.4
Poecilia reticulata	800	800		800
Salvelinus fontinalis, namaycush	659.7	660	723	723
Lepomis macrochirus	459.6	272	459.6	459.6
Rana clamitans	>50			50
Pteronarcys californica	25	25		25
Chironomus tentans	10.7		10.7	10.7
Hyalella azteca	6.51		4.3	4.3
Gammarus fasciatus, pseudolimnaeus	5.858		16.82	16.82
Physa sp.		4.41	4441	4441
Neomysis mercedis		4.15	4.15	4.15
Procloeon sp.			1.79	1.79
Simocephalus serrulatus	1.587	1.59		1.587
Daphnia magna, pulex	0.902	1.06	0.52	0.52
Ceriodaphnia dubia	0.3773	0.44	0.36	0.36
Lowest 4 values	5.858	4.15	4.15	1.79
	1.587	1.59	1.79	1.587
	0.9020	1.06	0.52	0.52
	0.3773	0.44	0.36	0.368
Log-triangular results				
Number of values	20	14	13	24
FAV/ 5th percentile*	0.34	0.31	0.17	0.40
Criterion	**0.17**	**0.16**	**0.090**	**0.20**
Criterion from agency report	0.17	0.16		

*The calculation yields a 5th percentile value (or the final acute value, FAV). This value is divided by 2 to obtain the criterion in both methods.

Table B-4. Burr Type III Calculation for Diazinon Species Mean Acute Values.

Genus species	EPA 2005	CDFG 2000	UCD 2007	Hypothetical Combination
	Diazinon Species Mean Acute Values (µg/L)			
Brachionus calyciflorus		29220		29220
Dugesia tigrina	11640			11640
Gillia altilis	11000			11000
Carrasius auratus	9000			9000
Danio rerio	8000	8000		8000
Lumbriculus variegatus	7841			7841
Pimephales promelas	7804	7804	7804	7804
Physa sp.		**4.41**	4441	4441
Pomacea paludosa	3198		3198	3198
Oncorhynchus clarki	2166	2166		2166
Jordanella floridae	1643	1643	1643	1643
Poecilia reticulata	800	800		800
Salvelinus fontinalis	723	723	723	723
Salvelinus namaycush	602	602		602
Lepomis macrochirus	459.6	272	460	460
Oncorhynchus mykiss	426	90		425.8
Rana clamitans	>50			50
Pteronarcys californica	**25**	**25**		**25**
Gammarus pseudolimnaeus	**16.82**		**16.82**	**16.82**
Chironomus tentans	**10.7**		**10.7**	**10.7**
Hyalella azteca	**6.51**		**4.3**	**4.3**
Neomysis mercedis		**4.15**	**4.15**	**4.15**
Procloeon sp.			**1.79**	**1.79**
Simocephalus serrulatus	**1.587**	**1.59**		**1.587**
Daphnia magna	**1.048**	**1.44**	**0.52**	**0.52**
Daphnia pulex	**0.7764**	**0.78**		**0.7764**
Ceriodaphnia dubia	**0.3773**	**0.44**	**0.36**	**0.36**
Gammarus fasciatus	**2.04**			**2.04**
Burr III results, using entire data set				
Number of values	24	17	13	28
5th percentile*	No result	Failed fit test	0.36	Failed fit test
Criterion			**0.18**	
Burr III results, calculated for Arthropoda subset, indicated by bolded values				
Number of values	9	7	7	11
5th percentile*	0.41	0.21	0.22	0.40
Criterion	**0.21**	0.11**	0.11**	**0.20**
Criterion from agency report	0.17	0.16		

*The calculation yields a 5th percentile value (or the final acute value, FAV). This value is divided by 2 to obtain the criterion in both methods.

**Log-Logistic distribution used for 8 or fewer data, according to UCD methods

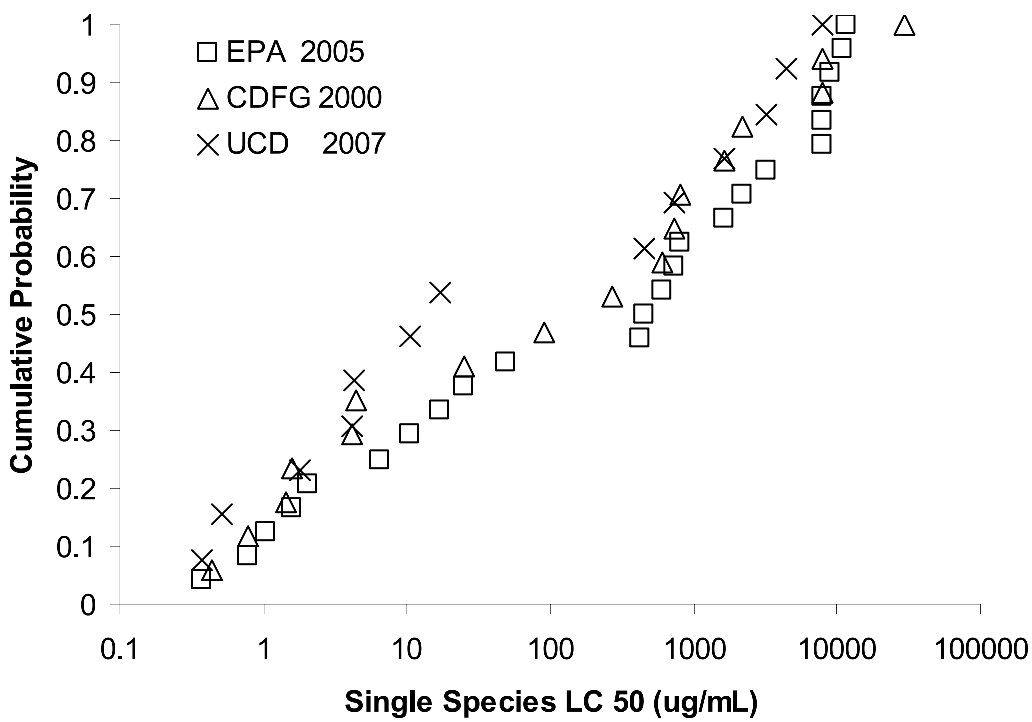

Figure B-1. Diazinon Acute Toxicity Data Distribution.

Note: Equivalent LC_{50} values will not overlap because probability (on y-axis) is relative to other values in the data set. Equivalent LC_{50} values will be vertically in line with each other (according to concentration on x-axis).

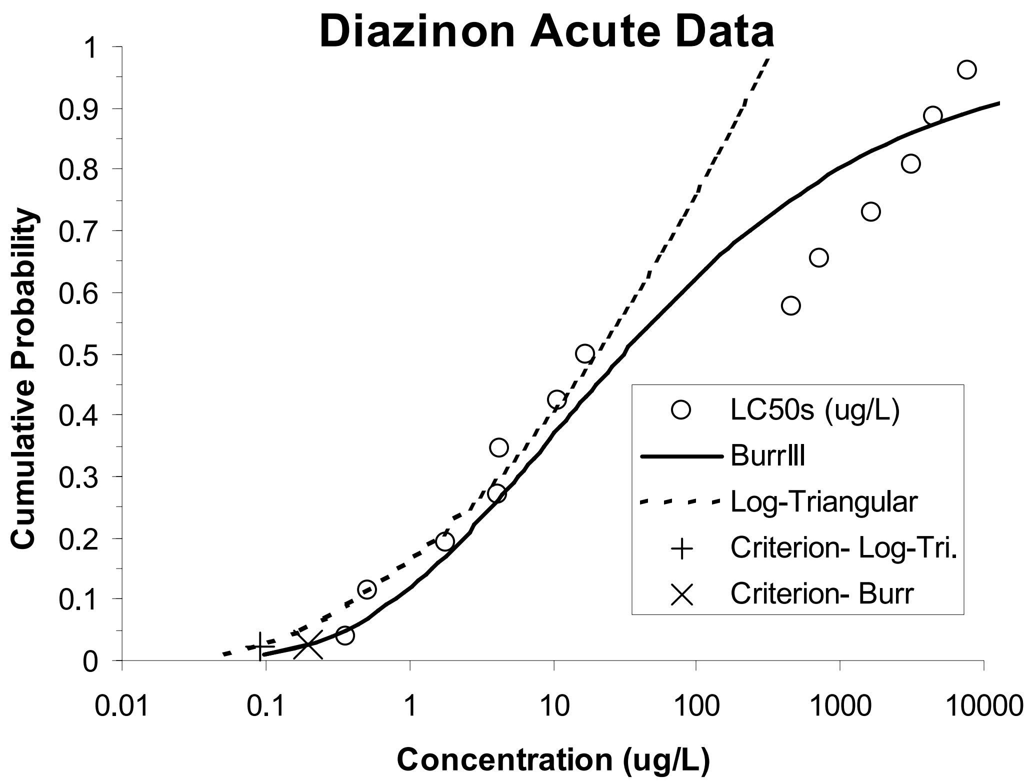

Figure B-2. The fit of the Burr Type III and Log-triangular distributions to the UCD diazinon acute data set

PART IV

Table B-5. Comparison of studies with acute and chronic toxicity data for diazinon used in different criteria reports.

Gray shading indicates that values from that study were not considered for ACR.

Reference	Organism	Used by EPA 2005			Used by CDFG 2000			UCD 2007			Comment
Freshwater species		LC_{50} µg/L	MATC µg/L	ACR	LC_{50} µg/L	MATC µg/L	ACR	LC_{50} µg/L	MATC µg/L	ACR	
Allison (1977)	*Jordanella floridae*	1643	68.93	23.8							Rejected by CDFG because it did not generate a NOEC. Rejected by UCD because control not described, no standard method, purity not reported.
Allison and Hermanutz (1977)	*Salvelinus fontinalis*	723	<0.8	904				723	6.8	106	Rejected by CDFG because it did not generate a NOEC. (for growth rate of progeny- the most sensitive endpoint). However that endpoint had interrupted dose repose. UCD used data for the survival endpoint.
Allison and Hermanutz (1977)	*Pimephales promelas*							7800	41	190	Chronic data not included in EPA and CDFG. Study abstract reports no NOEC (for incidence of scoliosis-most sensitive endpoint, but it is not linked to survival, growth, reproduction). UCD used data for the survival endpoint.
Jarvinen and Tanner (1982)	*Pimephales promelas*	6900	67.08	103	6900	67	103	6900	67	103	
Norberg-King (1989)	*Pimephales promelas*	9350	24.97	374	9350	25	374				Study did not rate as high quality be UCD because control response not reported and low reliability score
Norberg-King (1987)	*Ceriodaphnia dubia*	0.376	0.3382	**1.1**	0.57	0.34	**1.7**				CDFG states it is unavailable yet did include values. Report is a memorandum to USEPA. Study did not rate as high quality by UCD.
Surprenant (1988)	*Daphnia magna*				1.44	0.23	**6.3**	0.52	0.23	**2.3**	Not referenced at all by USEPA (EPA 1985 guidelines advised against using confidential studies and acute tests with feeding). CDFG used a geometric mean from multiple endpoints.
Saltwater species											
Goodman et al. (1979)	*Cyprinodon variegatus*	1400	<0.47	2979							Rejected by CDFG and UCD because it did not generate a NOEC
Nimmo et al. (1981)	*Mysidopsis bahia*	4.82	3.04	**1.6**	4.82	1.9	**2.5**				Rejected by UCD because diazinon purity was < 80%, control description & response not reported. EPA used original data to recalculate values. CDFG used value calculated by authors.
Final ACR (species values included in bold)				2*			3			2.3	All three agencies used the geometric mean of ACRs of species whose acute values were close to the FAV.

*EPA used 1985 Guidelines stipulation that if the most appropriate SMACRs < 2.0, the FACR should be assumed to be 2.0

Appendix C

Data summary sheets for data rated
relevant and reliable

Abbreviations used in this appendix:

NA = Not Applicable
NC = Non Calculable
NR = Not Reported

Unused lines deleted from tables

Studies are listed in alphabetical order by species name.

Ceriodaphnia dubia

Toxicity Data Summary

Study: Bailey HC, Miller JL, Miller MJ, Wiborg LC, Deanovic L, Shed T. 1997. Joint acute toxicity of diazinon and chlorpyrifos to *Ceriodaphnia dubia.* Environ Toxicol Chem 16: 2304-2308.

Relevance	Reliability
Score: 92.5 (no control description)	Score:85
Rating:R	Rating: R

Bailey *et al.* 1997		
Parameter	**Value**	**Comment**
Test method cited	USEPA 1991; EPA 600/4-90/027	
Phylum/subphylum	Arthropoda/Crustacea	
Class	Branchiopoda	
Order	Cladocera	
Family	Daphniidae	
Genus	*Ceriodaphnia*	
Species	*dubia*	
Found in	N. America	
Age/size at start of test/growth phase	< 24 h	
Source of organisms	Lab culture	
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	Yes	
Animals randomized?	Yes	
Test vessels randomized?	NR	
Test duration	24, 48, 72, 96 h	
Data for multiple times?	Yes	
Effect 1	Mortality	
Control response 1	<10%	
Temperature	25 $\pm$ 1 ^{o}C	
Test type	Static	
Photoperiod/light intensity	16L:8D	
Dilution water	Moderately hard synthetic water	
pH	7.40-8.23	Water quality
Hardness	80-100 mg/L as $CaCO_3$	within guidelines
Alkalinity	100-120 mg/L as $CaCO_3$	in USEPA 1991
Conductivity	290-300 umhos/cm	

Bailey *et al.* 1997		
Parameter	**Value**	**Comment**
Dissolved Oxygen	NR	
Feeding	None	
Purity of test substance	None	
Concentrations measured?	Yes	
Measured is what % of nominal?	106%	
Chemical method documented?	Yes	
Concentration of carrier (if any) in test solutions	< 0.1%	
Concentration 1 Nom (µg/L)	0.008	Reps: 4 w/5 per
Concentration 2 Nom (µg/L)	0.016	Reps: 4 w/5 per
Concentration 3 Nom (µg/L)	0.033	Reps: 4 w/5 per
Concentration 4 Nom (µg/L)	0.066	Reps: 4 w/5 per
Concentration 5 Nom (µg/L)	0.132	Reps: 4 w/5 per
Control	Methanol at < 0.1%	Reps: 4 w/5 per
LC50 (95% ci); µg/L	Test 1 24-h: 0.58 (0.54-0.63); Test 1 48-h: 0.58 (0.54-0.63); Test 1 72-h: 0.35 (0.29-0.42); <u>Test 1 96-h: 0.32</u> (0.27-0.38); Test 2 24-h: 0.75 (0.69-0.80); Test 2 48-h: 0.48 (0.41–0.56); Test 2 72-h: 0.40 (0.36–0.44); <u>Test 2 96-h: 0.35</u> (0.32–0.38); Test 3 24-h: 0.37 (0.33–0.42); Test 3 48-h: 0.26 (0.21–0.32); Test 4 24-h: 0.65 (0.46–0.92); Test 4 48-h: 0.29 (0.19–0.46)	Trimmed Spearman-Karber or binomial; based on measured values

Reliability points taken off for:
<u>Documentation:</u> Dissolved oxygen (4), Hypothesis tests (8)
<u>Acceptability:</u> Carrier solvent > 0.5 mL/L (4), Adequate # per rep (2), Organisms acclimated (1), Dissolved oxygen (6), Random design (2), Hypothesis tests (3)

Ceriodaphnia dubia

Toxicity Data Summary

Study: Bailey HC, Draloi R, Elphick JR, Mulhall A-M, Hunt P, Tedmanson L, Lovell A. 2000. Application of *Ceriodaphnia dubia* for whole effluent toxicity tests in the Hawkesbury-Nepean watershed, New South Wales, Australia: method development and validation. Environ Toxicol Chem 19: 88-93.

Relevance- acute
Score: 100
Rating: R

Relevance -chronic
Score: 85 (no values)
Rating: L

Reliability- acute
Score: 78
Rating: R

Bailey *et al.* 2000		
Parameter	**Value**	**Comment**
Test method cited	USEPA 1993, 1994 (acute and chronic)	
Phylum/subphylum	Arthropoda/crustacea	
Class	Branchiopoda	
Order	Cladocera	
Family	Daphniidae	
Genus	*Ceriodaphnia*	
Species	*dubia*	
Found in	N. Amer.	
Age/size at start of test/growth phase	Acute: < 24 h Chronic: < 24 h	
Source of organisms	Lab culture	
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	Yes	
Animals randomized?	NR	
Test vessels randomized?	NR	
Test duration	Acute: 48 h Chronic: 3 broods (6-8 d)	
Data for multiple times?	No	
Effect 1	Mortality	
Control response 1	Acute: $\geq$ 90% Chronic: within test guidelines	
Temperature	25 $\pm$ 1^{o}C	
Test type	Acute: static Chronic: static renewal	

Bailey *et al.* 2000		
Parameter	**Value**	**Comment**
	(daily)	
Photoperiod/light intensity	16L:8D	
Dilution water	20% Perrier	
pH	"Within satisfactory limits"	
Hardness	"Within satisfactory limits"	
Alkalinity	"Within satisfactory limits"	
Conductivity	"Within satisfactory limits"	
Dissolved Oxygen	"Within satisfactory limits"	
Feeding	Acute: none Chronic: daily with renewal	
Purity of test substance	Analytical grade	
Concentrations measured?	Yes	
Measured is what % of nominal?	NR	
Chemical method documented?	Yes	
Concentration of carrier (if any) in test solutions	< 0.1% methanol; < 1 mL/L	
Concentration 1 Meas (µg/L)	5 concentrations, but levels NR	Acute reps: 4 w/ 5 per Chronic reps: 10 w/1 per
Control	Dilution water; no mention of a solvent control	Acute reps: 4 w/ 5 per Chronic reps: 10 w/1 per
LC50; µg/L	Acute: 0.33 (mean of 12 tests); Chronic: 0.14 (one test)	Trimmed Spearman-Karber or binomial probability

NOEC values for chronic test NR; no reproduction numbers reported for chronic test.

Reliability points taken off for:
<u>Documentation:</u> Control type (8), Nominal concentrations (3), Measured concentrations (3), Hypothesis tests (8)
<u>Acceptability:</u> Control type (6), Measured conc within 20% of nominal (4), Concentrations do not exceed 2x water solubility (4), Orgs randomly assigned (1), Random design (2), Dilution factor (2), Hypothesis tests (3)

Ceriodaphnia dubia

Toxicity Data Summary

Study: Bailey HC, Elphick JR, Krassoi R, Lovell A. 2001. Joint acute toxicity of diazinon and ammonia to *Ceriodaphnia dubia*. Environ Toxicol Chem 20: 2877-2882.

Relevance	Reliability
Score: 100	Score: 78.5
Rating: R	Rating: R

Bailey *et al.* 2001		
Parameter	**Value**	**Comment**
Test method cited	USEPA 1993	Full reference below
Phylum/subphylum	Arthropoda/Crustacea	
Class	Branchiopoda	
Order	Cladocera	
Family	Daphniidae	
Genus	*Ceriodaphnia*	
Species	*dubia*	
Found in	North America	
Age/size at start of test/growth phase	< 24 h	
Source of organisms	Lab culture	
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	Yes	
Animals randomized?	Yes	
Test vessels randomized?	NR	
Test duration	48 h	
Data for multiple times?	No	
Effect 1	Mortality	
Control response 1	0%	
Temperature	25 $\pm$ 1^{o}C	
Test type	Static	
Photoperiod/light intensity	16L:8D	
Dilution water	Moderately hard water	
pH	8.0	
Hardness	90 mg/L	
Alkalinity	80 mg/L	
Conductivity	NR	
Dissolved Oxygen	NR	
Feeding	None	

Bailey *et al.* 2001		
Parameter	**Value**	**Comment**
Purity of test substance	99%	
Concentrations measured?	Yes, but only the highest concentration	
Measured is what % of nominal?	NR	
Chemical method documented?	Yes	
Concentration of carrier (if any) in test solutions	< 0.1% methanol	
Concentration 1 Nom (µg/L)	0.06	Reps: 4 w/5 per
Concentration 2 Nom (µg/L)	0.12	Reps: 4 w/5 per
Concentration 3 Nom (µg/L)	0.25	Reps: 4 w/5 per
Concentration 4 Nom (µg/L)	0.50	Reps: 4 w/5 per
Concentration 5 Nom (µg/L)	1.0	Reps: 4 w/5 per
Control	Dilution water	Reps: 4 w/5 per
LC50; µg/L	Test 1 24 h: 0.46 Test 1 48 h: 0.38 Test 2 24 h: 0.57 Test 2 48 h: 0.33	Trimmed Spearman-Karber; Geomean of concentrations bracketing LC50 w/binomial probability if no partial responses

USEPA. 1993. Methods for measuring the acute toxicity of effluents and receiving waters to freshwater and marine organisms, 3rd edition. EPA 600/4-90/027F. US Environmental Protection Agency, Washington, DC.

Reliability points taken off for:
Documentation: Measured concentrations (3), Dissolved oxygen (4), Conductivity (2), Hypothesis tests (8)
Acceptability: Appropriate control (6), Measured concentration w/in 20% of nominal (4), Carrier solvent > 0.05% (4), Dissolved oxygen (6), Conductivity (1), Random design (2), Hypothesis tests (3)

Ceriodaphnia dubia

Toxicity Data Summary

Study: Banks KE, Wood SH, Matthews C, Thuesen KA. 2003. Joint acute toxicity of diazinon and copper to *Ceriodaphnia dubia*. Environ Toxicol Chem 22: 1562-1567.

Relevance
Score: 92.5 (Controls not described)
Rating: R

Reliability
Score: 83
Rating: R

Banks *et al.* 2003		
Parameter	**Value**	**Comment**
Test method cited	USEPA 1993	
Phylum/subphylum	Arthropoda/Crustacea	
Class	Branchiopoda	
Order	Cladocera	
Family	Daphniidae	
Genus	*Ceriodaphnia*	
Species	*dubia*	
Found in	North America	
Age/size at start of test/growth phase	< 24 h	
Source of organisms	Lab culture	
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	Yes	
Animals randomized?	Yes	
Test vessels randomized?	NR	
Test duration	48 h	
Data for multiple times?	No	
Effect 1	Mortality	
Control response 1	< 10%	
Temperature	$25 \pm 1^{o}C$	
Test type	Static	
Photoperiod/light intensity	16L:8D	
Dilution water	Reconstituted hard water	
pH	8.35-8.36	
Hardness	175 ± 11.5 mg/L as $CaCO_3$	
Alkalinity	136 ± 9.5 mg/L as $CaCO_3$	
Conductivity	542 μmhos/cm	
Dissolved Oxygen	8.27 ± 0.06 mg/L	
Feeding	None	

Banks *et al.* 2003		
Parameter	**Value**	**Comment**
Purity of test substance	99.8%	
Concentrations measured?	No; stock solutions measured	
Measured is what % of nominal?	Stock solutions: 105%	
Chemical method documented?	Yes, but calibration range makes no sense	
Concentration of carrier (if any) in test solutions	None used	
Concentration 1 Nom (µg/L)	0.05	Reps: 4 w/5 per
Concentration 2 Nom (µg/L)	0.10	Reps: 4 w/5 per
Concentration 3 Nom (µg/L)	0.20	Reps: 4 w/5 per
Concentration 4 Nom (µg/L)	0.40	Reps: 4 w/5 per
Concentration 5 Nom (µg/L)	0.80	Reps: 4 w/5 per
Control	Not described	Reps: 4 w/5 per
LC50 (95% ci); µg/L	0.45 (0.36-0.57)	Logistic regression

Reliability points taken off for:
Documentation: Control type (8), Measured concentrations (3), Hypothesis tests (8)
Acceptability: Appropriate control (6), Measured conc w/in 20% of nominal (4), Random design (2), Hypothesis tests (3)

Ceriodaphnia dubia

Toxicity Data Summary

Banks KE, Turner PK, Wood SH, Matthews C. 2005. Increased toxicity to *Ceriodaphnia dubia* in mixtures of atrazine and diazinon at environmentally realistic concentrations. *Ecotoxicol Environ Safety* 60: 28-36.

Relevance
Score: 100
Rating: R

Reliability
Score: 92
Rating: R

Banks *et al.* 2005		
Parameter	**Value**	**Comment**
Test method cited	USEPA 1993 acute	
Phylum/subphylum	Arthropoda/Crustacea	
Class	Branchiopoda	
Order	Cladocera	
Family	Daphniidae	
Genus	*Ceriodaphnia*	
Species	*dubia*	
Found in	North America	
Age/size at start of test/growth phase	< 24 h	
Source of organisms	Lab culture	
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	Yes	
Animals randomized?	Yes	
Test vessels randomized?	NR	
Test duration	48 h	
Data for multiple times?	No	
Effect 1	Mortality	
Control response 1	$\leq$ 10%	
Temperature	25 $\pm$ 1^{o} C	
Test type	Static	
Photoperiod/light intensity	16L:8D	
Dilution water	Reconstituted hard water	
pH	8..35-8.36	
Hardness	175 $\pm$ 11.5 mg/L as $CaCO_3$	
Alkalinity	136 $\pm$ 9.5 mg/L as $CaCO_3$	
Conductivity	542 $\pm$ 7.6 uS/cm	
Dissolved Oxygen	8.27 $\pm$ 0.06 mg/L	
Feeding	None	

Banks *et al.* 2005		
Parameter	**Value**	**Comment**
Purity of test substance	99.8%	
Concentrations measured?	Yes	
Measured is what % of nominal?	93%	
Chemical method documented?	Yes	
Concentration of carrier (if any) in test solutions	None used	
Concentration 1 Nom/Meas (μg/L)	0.10/NR	Reps: 4 w/5 per
Concentration 2 Nom/Meas (μg/L)	0.20/NR	Reps: 4 w/5 per
Concentration 3 Nom/Meas (μg/L)	0.40/NR	Reps: 4 w/5 per
Concentration 4 Nom/Meas (μg/L)	0.6/NR	Reps: 4 w/5 per
Control	Dilution water	Reps: 4 w/5 per
LC50; μg/L	0.21 (0.17-0.25)	Curve-fitting; logistic response model

Reliability points taken off for:
<u>Documentation:</u> Measured concentrations (3), Hypothesis tests (3)
<u>Acceptability</u>: Random design (2), Hypothesis tests (3)

Ceriodaphnia dubia

Toxicity Data Summary

Study: CDFG. 1998 a. Test No. 122. 96-h acute toxicity of diazinon to *Ceriodaphnia dubia*, Aquatic Toxicology Laboratory, Elk Grove, California.

Relevance
Score: 100
Rating: R

Reliability
Score: 96
Rating: R

CDFG No. 122 1998 a		
Parameter	**Value**	**Comment**
Test method cited	USEPA 1993; ASTM 1988 (E729-88 and E1192-88)	
Phylum/subphylum	Arthropoda/crustacea	
Class	Branchiopoda	
Order	Cladocera	
Family	Daphniidae	
Genus	*Ceriodaphnia*	
Species	*dubia*	
Found in	N. Amer.	
Age/size at start of test	< 24 h	
Source of organisms	Lab culture	
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	Yes	
Animals randomized?	Yes	
Test vessels randomized?	Yes	
Test duration	96 h	
Data for multiple times?	Yes	
Effect 1	Mortality	
Control response 1	0%	
Temperature; mean (range); ^{o}C	24.7 (24.2-25.2)	
Test type	Static; renewal	
Photoperiod	16L:8D	
Dilution water	Aquat Tox Lab well water	
pH; mean (range)	8.055 (7.62-8.19)	
Hardness; mg/L as $CaCO_3$	132-140	Measurement NR, but this is typical well water level
Alkalinity; mg/L as $CaCO_3$	144-159	Measurement NR, but this is typical well water level

CDFG No. 122 1998 a		
Parameter	**Value**	**Comment**
Conductivity; mean (range); uS/cm	267 (263-271)	
Dissolved Oxygen; mean (range); mg/L	7.69 (6.23-8.19)	
Feeding	YCT:*Selenastrum*; 2 h prior to test; 2 h prior to each renewal	
Purity of test substance	87.3%	
Concentrations measured?	Yes	
Measured is what % of nominal?	81.6%	
Chemical method documented?	Yes	
Concentration of carrier (if any) in test solutions	None used	
Concentration 1 Meas (μg/L)	0.1	Reps: 4 w/5 per
Concentration 2 Meas (μg/L)	0.17	Reps: 4 w/5 per
Concentration 3 Meas (μg/L)	0.25	Reps: 4 w/5 per
Concentration 4 Meas (μg/L)	0.4	Reps: 4 w/5 per
Concentration 5 Meas (μg/L)	0.8	Reps: 4 w/5 per
Control	Dilution water; measured 0.14 ppm in one rep; 0 ppm in second rep	Reps: 4 w/5 per
LC50 (95% ci); ug/L	0.436 (0.342-0.504)	Moving average
NOEC; indicate calculation method	0.25	Likely Chi-Square, but NR
LOEC; indicate calculation method	0.4	
MATC (GeoMean NOEC,LOEC)	0.32	
% of control at NOEC	95%	
% of control at LOEC	60%	

Reliability points taken off for:
Documentation: Nominal concentrations (3), Significance level (2), Minimum significant difference (2)
Acceptability: Minimum significant difference (1)

Ceriodaphnia dubia

Toxicity Data Summary

Study: CDFG. 1992 a. Test No. 157. 96-h acute toxicity of chlorpyrifos to *Ceriodaphnia dubia*.

Relevance
Score: 100
Rating: R

Reliability
Score: 96
Rating: R

CDFG No. 157 1992 a		
Parameter	**Value**	**Comment**
Test method cited	ASTM 1988; USEPA 1993	
Phylum/subphylum	Arthropoda/crustacea	
Class	Branchiopoda	
Order	Cladocera	
Family	Daphniidae	
Genus	*Ceriodaphnia*	
Species	*dubia*	
Found in	N. Amer.	
Age/size at start of test	< 24 h	
Source of organisms	Lab culture	
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	Yes	
Animals randomized?	Yes	
Test vessels randomized?	Yes	
Test duration	96 h	
Data for multiple times?	Yes; see study	
Effect 1	Mortality	
Control response 1	5%	
Temperature; mean (range); ^{o}C	24.41 (23.8-24.9)	
Test type	Static renewal; daily renewal	
Photoperiod	16L:8D	
Dilution water	Aquat Tox Lab well water	
pH; mean (range)	8.27 (7.79-8.50)	
Hardness; mean (range); mg/L as $CaCO_3$	123.5 (123-124)	
Alkalinity; mean (range); mg/L as $CaCO_3$	112	
Conductivity; mean (range); uS/cm	382.5 (360-400)	
Dissolved Oxygen; mean (range);	8.03 (7.61-8.60)	

CDFG No. 157 1992 a		
Parameter	**Value**	**Comment**
mg/L		
Feeding	YCT:*Selenastrum* 2 h prior to test and 2 hr prior to each renewal	
Purity of test substance	88%	
Concentrations measured?	Yes	
Measured is what % of nominal?	104.7%	
Chemical method documented?	Yes	
Concentration of carrier (if any) in test solutions	0.026 mL/L	
Concentration 1 Meas (μg/L)	0.105	Reps: 4 w/5 per
Concentration 2 Meas (μg/L)	0.200	Reps: 4 w/5 per
Concentration 3 Meas (μg/L)	0.354	Reps: 4 w/5 per
Concentration 4 Meas (μg/L)	0.625	Reps: 4 w/5 per
Concentration 5 Meas (μg/L)	1.10	Reps: 4 w/5 per
Control	Dilution water; solvent (triethylene glycol dimethyl ether, triethylene glycol, ≤ 0.0263 mL/L)	Reps: 4 w/5 per
LC50 (95% ci); ug/L	0.470 (0.354-0.625); ci doesn't seem right; numbers are same as NOEC and LOEC	Non-linear interpolation
NOEC; ug/L	0.354	Chi square
LOEC; ug/L	0.625	
MATC (GeoMean NOEC,LOEC)	0.470	
% of control at NOEC	100%	
% of control at LOEC	0%	

Reliability points taken off for:
Documentation: Nominal concentrations (3), Significance level (2), Minimum significant difference (2)
Acceptability: Minimum significant difference (1)

Ceriodaphnia dubia

Toxicity Data Summary

Study: CDFG. 1992b. Test No. 163. 96-h acute toxicity of chlorpyrifos to *Ceriodaphnia dubia*.

Relevance
Score: 100
Rating: R

Reliability
Score: 97
Rating: R

CDFG 163 1992b		
Parameter	**Value**	**Comment**
Test method cited	ASTM 1988; USEPA 1993	
Phylum/subphylum	Arthropoda/crustacea	
Class	Branchiopoda	
Order	Cladocera	
Family	Daphniidae	
Genus	*Ceriodaphnia*	
Species	*dubia*	
Found in	N. Amer.	
Age/size at start of test/growth phase	< 24 h	
Source of organisms	Lab culture	
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	Yes	
Animals randomized?	Yes	
Test vessels randomized?	Yes	
Test duration	96 h	
Data for multiple times?	Yes; see study	
Effect 1	Mortality	
Control response 1	0%	
Temperature; mean (range)	24.4 (24.0-24.7) ^{o}C	
Test type	Static renewal; daily renewal	
Photoperiod/light intensity	16L:8D	
Dilution water	Aquat Tox Lab well water	
pH; mean (range)	8.5 (8.2-8.8)	
Hardness; mean (range)	125 (124-126) mg/L $CaCO_3$	
Alkalinity; mean (range)	100 (100-100) mg/L $CaCO_3$	
Conductivity; mean (range)	389 (385-390) uS/cm	
Dissolved Oxygen; mean (range)	7.8 (6.9-9.0) mg/L	
Feeding	YCT:*Selenastrum* 2 h prior	

CDFG 163 1992b		
Parameter	**Value**	**Comment**
	to test and 2 hr prior to each renewal	
Purity of test substance	88%	
Concentrations measured?	Yes	
Measured is what % of nominal?	105%	
Chemical method documented?	Yes	
Concentration of carrier (if any) in test solutions	≤ 0.0267 mL/L; triethylene glycol dimethyl ether; triethylene glycol	
Concentration 1 Meas (µg/L)	0.1	Reps: 2 w/5 per
Concentration 2 Meas (µg/L)	0.17	Reps: 2 w/5 per
Concentration 3 Meas (µg/L)	0.345	Reps: 2 w/5 per
Concentration 4 Meas (µg/L)	0.605	Reps: 2 w/5 per
Concentration 5 Meas (µg/L)	1.1	Reps: 2 w/5 per
Control	Dilution water; solvent (triethylene glycol dimethyl ether, triethylene glycol, ≤ 0.0267 mL/L)	Reps: 2 w/5 per
LC50; (95% ci); µg/L	0.507 (0.42-0.71)	Non-linear interpolation
NOEC; indicate calculation method, significance level (p-value) and minimum significant difference (MSD)	0.345 µg/L	Method: Not available; likely Chi square p: 0.05 MSD: NR
LOEC; indicate calculation method	0.605 µg/L	
MATC (GeoMean NOEC,LOEC)	0.46 µg/L	
% control at NOEC	100%	
% of control LOEC	20%	

Reliability points taken off for:
<u>Documentation:</u> Nominal concentrations (3), Minimum significant difference (2)
<u>Acceptability:</u> Minimum significant difference (1)

Chironomus dilutus (tentans)

Toxicity Data Evaluation

Study: Ankley GT, Collyard SA. 1995. Influence of piperonyl butoxide on the toxicity of organophosphate insecticides to three species of freshwater benthic invertebrates. Comp Biochem Physiol 110C: 149-155.

Notes: Using only data for diazinon only exposures; water quality information, test substance purity, replication, other information given as ranges for all tests and compounds; not possible to match specific data with each test.

Relevance
Score: 92.5 (Control response NR)
Rating: R

Reliability
Score: 76.5
Rating: R

Ankley & Collyard 1995		
Parameter	**Value**	**Comment**
Test method cited	None cited, but appears to follow EPA acute methods	Study by EPA staff
Phylum	Arthropoda	
Class	Insecta	
Order	Diptera	
Family	Chironomidae	
Genus	*Chironomus*	
Species	*tentans*	
Native to	North America	
Age/size at start of test	Third instar	
Test duration	96 h	
Source of organisms	Lab culture	
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	Yes	
Animals randomized?	NR	
Test vessels randomized?	NR	
Data for multiple times?	No	
Effect 1	Mortality/immobility	
Control response 1	NR	
Temperature	23 $\pm$ 1 ^{o}C	
Test type	Static	
Photoperiod	16L:8D	
Dilution water	Lake Superior water; as is, or with added hardness	
pH	7.4-8.5	

Ankley & Collyard 1995		
Parameter	**Value**	**Comment**
Hardness	42-47 mg/L as $CaCO_3$	Hardness adjusted to 105 mg/L as $CaCO_3$, but not clear for which species in the study
Alkalinity	39-46 mg/L as $CaCO_3$	
Conductivity	NA	
Dissolved Oxygen	5.2-8.1 mg/L	
Feeding	None	
Purity of test substance	$\geq$ 95% pure	
Concentrations measured?	No	
Measured is what % of nominal?	NA	
Chemical method documented?	NA	
Concentration of carrier (if any) in test solutions	$\leq$ 15% (15 mL/L; shown to be non-toxic)	
Concentration 1 Nom/Meas (µg/L)	NR	Reps: 2-4 w/5-10 per
Concentration 2 Nom/Meas (µg/L)	NR	Reps: 2-4 w/5-10 per
Concentration 3 Nom/Meas (µg/L)	NR	Reps: 2-4 w/5-10 per
Concentration 4 Nom/Meas (µg/L)	NR	Reps: 2-4 w/5-10 per
Control?	Methanol carrier at $\leq$ 1.5%	Reps: 2-4 w/5-10 per
LC50; (95% ci)	10.7 ug/L (7.55-15.2)	Trimmed Spearman-Karber

Reliability points taken off for:
Documentation: Analytical method (4), Nominal concentrations (3), Measured concentrations (3), Conductivity (2), Hypothesis tests (8)
Acceptability: Control response (9), Measured conc w/in 20% nominal (4), Carrier solvent (4), Organisms randomized (1), Conductivity (1), Random design (2), Dilution factor (2), Hypothesis tests (3)

Chironomus dilutus (tentans)

Toxicity Data Summary

Study: Belden JB, Lydy MJ. 2000. Impact of atrazine on organophosphate insecticide toxicity. *Environ Toxicol Chem* 19: 2266-2274.

Notes: Study showed significant synergism between diazinon and atrazine. Only data for diazinon alone is shown here for use in criteria derivation, but synergism data is useful for consideration of mixtures.

Relevance
Score: 92.5 (Control response NR)
Rating: R

Reliability
Score: 79
Rating: R

Belden & Lydy 2000		
Parameter	**Value**	**Comment**
Test method cited	USEPA 1994	See full reference below
Phylum	Arthropoda	
Class	Insecta	
Order	Diptera	
Family	Chironomidae	
Genus	*Chironomus*	
Species	*tentans*	
Found in	North America	
Age/size at start of test	4^{th} instar; 0.63-0.71 mm wide; $\geq$ 1.0 cm long	
Source of organisms	Lab culture	
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	Yes	
Animals randomized?	NR	
Test vessels randomized?	NR	
Test duration	96 h	
Data for multiple times?	No	
Effect 1	Immobility + Mortality	
Control response 1	NR	
Temperature	20 ± 1^{o} C	
Test type	Static	
Photoperiod	16L:8D	
Dilution water	MHSFW	
pH	7.3-7.8	

Belden & Lydy 2000		
Parameter	**Value**	**Comment**
Hardness	NR	
Alkalinity	NR	
Conductivity	320-350 uS/cm	
Dissolved Oxygen	> 70%	
Feeding	NR	
Purity of test substance	> 98%	
Concentrations measured?	Yes	Nominal values used in calcs since measured values were w/in 10% (likely w/in error of extraction and analysis procedure)
Measured is what % of nominal?	> 90%	
Chemical method documented?	Yes	
Concentration of carrier (if any) in test solutions	50 μL/L acetone	
Concentration 1 Nom/Meas (μg/L)	NR; post-test values were 76-85% of initial values	Reps: 3 w/10 per
Concentration 2 Nom/Meas (μg/L)	NR; post-test values were 76-85% of initial values	Reps: 3 w/10 per
Concentration 3 Nom/Meas (μg/L)	NR; post-test values were 76-85% of initial values	Reps: 3 w/10 per
Concentration 4 Nom/Meas (μg/L)	NR; post-test values were 76-85% of initial values	Reps: 3 w/10 per
Concentration 5 Nom/Meas (μg/L)	NR; post-test values were 76-85% of initial values	Reps: 3 w/10 per
Control	Dilution water; solvent	Reps: 3 w/10 per
ECx (95% ci); ug/L	EC1: 4.4 (2.0-7.1) EC5: 7.7 (4.2-11) EC15: 13 (8.2-17) EC50: 30 (24-36)	probit

USEPA. 1994. Methods for measuring the toxicity and bioaccumulation of sediment-associated contaminant with freshwater invertebrates. EPA/600/R-94/024. US Environmental Protection Agency, Washington, DC.

Reliability points taken off for:
<u>Documentation:</u> Nominal concentrations (3), Measured concentrations (3), Hardness (2), Alkalinity (2), Hypothesis tests (8)
<u>Acceptability:</u> Control response (9), Organisms randomized (1), Appropriate feeding (3), Hardness (2), Alkalinity (2), Random design (2), Dilution factor (2), Hypothesis tests (3)

Chironomus tentans

Toxicity Data Summary

Study: Lydy MJ, Austin KR. 2004. Toxicity assessment of pesticide mixtures typical of the Sacramento-San Joaquin Delta using *Chironomus tentans*. Arch Environ Contam Toxicol 48: 49-55.

Relevance
Score: 100
Rating: R

Reliability
Score: 83
Rating: R

Lydy & Austin 2004		
Parameter	**Value**	**Comment**
Test method cited	EPA/600/R-94/024	USEPA 1994
Phylum	Arthropoda	
Class	Insecta	
Order	Diptera	
Family	Chironomidae	
Genus	*Chironomus*	
Species	*tentans*	
Found in	North America	
Age/size at start of test/growth phase	4^{th} instar	
Source of organisms	Lab culture	
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	Yes	
Animals randomized?	NR	
Test vessels randomized?	NR	
Test duration	96 h	
Data for multiple times?	No	
Effect 1	Unable to perform figure 8 when prodded	
Control response 1	< 10%	
Temperature	$21 \pm 2^{o}C$	
Test type	Static	
Photoperiod/light intensity	16:8	
Dilution water	MHSFW	
pH	7.8-8.2	
Hardness	MH water (NR)	
Alkalinity	MH water (NR)	
Conductivity	320-360 uS/cm	
Dissolved Oxygen	> 75%	

Lydy & Austin 2004		
Parameter	**Value**	**Comment**
Feeding	None	
Purity of test substance	99.5%	
Concentrations measured?	Yes	
Measured is what % of nominal?	> 90%	
Chemical method documented?	Yes	
Concentration of carrier (if any) in test solutions	100 uL/L	
Concentration 1 Nom/Meas (μg/L)	5 concentrations; levels NR	Reps: 3 w 10 per
Control	Solvent	Reps: 3 w 10 per
EC50 (95% ci); ug/L	19.1 (13.6-24.1)	Method NR

Reliability points taken off for:
Documentation: Nominal concentrations (3), Measured concentrations (3), Hardness (2), Alkalinity (2), Statistical method (5), Hypothesis tests (8)
Acceptability: Organisms randomized (1), Hardness (2), Alkalinity (2), Temperature held +/- 1^{o}C (3), Statistical methods (2), Random design (2), Dilution factor (2), Hypothesis tests (3)

Daphnia magna

Toxicity Data Summary

Surprenant DC. 1988a. The chronic toxicity of ^{14}C-diazinon technical to *Daphnia magna* under flow-through conditions, EPA guidelines No. 72-4. Agricultural Division, Ciba-Geigy Corporation, Greensboro, NC.

Acute and chronic

Relevance
Score: 100
Rating: R

Reliability
Score: chronic: 93, acute: 90
Rating: R

Surprenant 1988a		
Parameter	**Value**	**Comment**
Test method cited	USEPA 1985	Reference below
Phylum/subphylum	Arthropoda/Crustacea	
Class	Branchiopoda	
Order	Cladocera	
Family	Daphniidae	
Genus	*Daphnia*	
Species	*magna*	
Found in	N. America	
Age/size at start of test/growth phase	< 24 h	
Source of organisms	Lab culture	
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	Yes	
Animals randomized?	Yes	
Test vessels randomized?	NR	
Test duration	21 d	
Data for multiple times?	Yes; acute & chronic	
Effect 1	Survival/immobilization	
Control response 1	97% @ 21 d	
Effect 2	Growth (length)	
Control response 2	4.6 mm	
Effect 3	Reproduction	
Control response 3	131 offspring/surviving female	
Temperature	20 ± 1^{o} C	
Test type	Flow-through	
Photoperiod/light intensity	16L:8D	

Surprenant 1988a		
Parameter	**Value**	**Comment**
Dilution water	Fortified well water, filtered	
pH	8.1-8.3	
Hardness	170-180 mg/L as $CaCO_3$	
Alkalinity	130 mg/L as $CaCO_3$	
Conductivity	490 μmhos/cm	
Dissolved Oxygen	> 60%	
Feeding	Yeast, algae, protein/fatty acid mix; 2-3x daily	
Purity of test substance	87.7%	
Concentrations measured?	Yes	
Measured is what % of nominal?	Mean of all solns: 64% Mean of highest conc: 91%	
Chemical method documented?	Yes	
Concentration of carrier (if any) in test solutions	24 μL/L	
Concentration 1 Nom/Meas (μg/L)	0.063/0.027	Reps: 4 w/ 10 per
Concentration 2 Nom/Meas (μg/L)	0.13/0.082	Reps: 4 w/ 10 per
Concentration 3 Nom/Meas (μg/L)	0.25/0.17	Reps: 4 w/ 10 per
Concentration 4 Nom/Meas (μg/L)	0.50/0.32	Reps: 4 w/ 10 per
Concentration 5 Nom/Meas (μg/L)	1.0/0.83	Reps: 4 w/ 10 per
Control	Dilution water; solvent	Reps: 4 w/ 10 per
EC50 (95% ci; immobilization); μg/L	48-h: 0.78 (0.32-infinity) 96-h: 0.52 (0.32-0.83) 7-d: 0.41 (0.32-0.83) 14-d: 0.23 (0.17-0.32) 21-d: 0.20 (0.16-0.25)	Non-linear interpolation
NOEC; μg/L	0.17 (survival @ 21 d); no differences from control with growth or reproduction	Method: Kruskal-Wallis ANOVA by ranks p: 0.05 MSD: NR
LOEC; μg/L	0.32 (survival @ 21 d)	
MATC (GeoMean NOEC,LOEC); μg/L	0.23 (survival @ 21 d)	
% control at NOEC	102%	
% of control LOEC	0%	

USEPA. 1985. Toxic substances control act guidelines. Federal Register, Vol. 50, No. 188, September 27, 1985. Daphnid toxicity test," pp. 39333-39336, US Environmental Protection Agency, Washington, DC.

ACR = 96-h EC50/MATC = 0.52/0.23 = 2.26

Reliability points taken off for:
<u>Documentation:</u> Minimum significant difference (2)
<u>Acceptability:</u> Measured conc w/in 20% of nominal (4), Appropriate feeding (3 – acute only), Random design (2), Minimum significant difference (1)

Gammarus pseudolimnaeus

Toxicity Data Summary

Study: Hall LW Jr, Anderson RD. 2005. Acute toxicity of diazinon to the amphipod, *Gammarus pseudolimnaeus*: implications for water quality criteria. Bull Environ Contam Toxicol 74: 94-99.

Relevance
Score: 100
Rating: R

Reliability
Score: 85.5
Rating: R

This study has raw acute data that may be used with the ACE program to estimate chronic toxicity.

Study also includes a note indicating that the LC50 value of 0.2 µg/L reported for *G. fasciatus* by Johnson & Finley (1980) and Mayer and Ellersieck (1986) is not correct and should be 2 µg/L. Those tests were not accepted for chlorpyrifos criteria derivation and are not likely to meet quality requirements for diazinon criteria.

Hall & Anderson 2005		
Parameter	**Value**	**Comment**
Test method cited	USEPA 1986; modified as per Hall & Anderson 2004	Full references below
Phylum	Arthropoda	
Class	Malacostraca	
Order	Amphipoda	
Family	Gammaridae	
Genus	*Gammarus*	
Species	*pseudolimnaeus*	
Found in	N. America	
Age/size at start of test/growth phase	Mature	
Source of organisms	Lab culture	
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	Yes	
Animals randomized?	NR	
Test vessels randomized?	NR	
Test duration	96 h	
Data for multiple times?	Yes	May be used with ACE program
Effect 1	Mortality	
Control response 1	< 20%	
Temperature	17.8-18.1°C	

Hall & Anderson 2005		
Parameter	**Value**	**Comment**
Test type	Static-renewal	
Photoperiod/light intensity	NR	
Dilution water	Well water	
pH	8.26-8.31	
Hardness	62.5 mg/L	
Alkalinity	100 mg/L	
Conductivity	261.1-263.1 µS/cm	
Dissolved Oxygen	8.95-9.44 mg/L	
Feeding	NR	
Purity of test substance	100%	
Concentrations measured?	Yes	
Measured is what % of nominal?	105%	
Chemical method documented?	Yes	
Concentration of carrier (if any) in test solutions	None used	
Concentration 1 Nom/Meas (µg/L)	2/2.24	Reps: 4 w/10 per
Concentration 2 No/Meas (µg/L)	4/4.34	Reps: 4 w/10 per
Concentration 3 Nom/Meas (µg/L)	8/8.32	Reps: 4 w/10 per
Concentration 4 Nom/Meas (µg/L)	16/15.52	Reps: 4 w/10 per
Concentration 5 Nom/Meas (µg/L)	32/32.48	Reps: 4 w/10 per
Control	Dilution water	Reps: 4 w/10 per
LC50 (95% ci); µg/L	48 h: 27.29 (22.45-33.18) 72 h: 20.21 (15.79-25.87) 96 h: 16.82 (12.82-22.08)	Trimmed-Spearman Karber

USEPA. 1986. Ecological effects test guidelines OPPTS 850.1020 Gammarid acute toxicity test. EPA 712-C-96-130, US Environmental Protection Agency, Office of Water, Office of Science and Technology, Health and Criteria Division, Washington, DC.

Hall LW, Anderson RD. 2004. Acute toxicity of diazinon to the amphipod *Gammarus pseudolimnaeus*. Data report. University of Maryland, Wye Research and Education Center, Queenstown, MD.

Reliability points taken off for:
Documentation: Photoperiod (3), Hypothesis tests (8)
Acceptability: Control response (9), Organisms randomized (1), Appropriate feeding (3), Random design (2), Hypothesis tests (3)

Hyalella azteca

Toxicity Data Summary

Study: Anderson TD, Lydy MJ. 2002. Increased toxicity to invertebrates associated with a mixture of atrazine and organophosphate insecticides. Environ Toxicol Chem 21: 1507-1514.

Relevance
Score: 92.5
Rating: R

Reliability
Score: 76
Rating: R

Anderson & Lydy 2002		
Parameter	**Value**	**Comment**
Test method cited	EPA -600-R-94-024	USEPA 1994
Phylum	Arthropoda	
Class	Malacostraca	
Order	Amphipoda	
Family	Hyalellidae	
Genus	*Hyalella*	
Species	*azteca*	
Found in	N. America	
Age/size at start of test/growth phase	14-21 d	
Source of organisms	Lab culture	
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	Yes	
Animals randomized?	NR	
Test vessels randomized?	NR	
Test duration	96 h	
Data for multiple times?	No	
Effect 1	Mortality	
Control response 1	NR	
Temperature	$20 \pm 1^{o}C$	
Test type	Static	
Photoperiod/light intensity	16:8	
Dilution water	NR	
pH	7.3-7.5	
Hardness	NR	
Alkalinity	NR	
Conductivity	331-359 uS/cm	
Dissolved Oxygen	$\geq$ 81%	
Feeding	None	

Anderson & Lydy 2002		
Parameter	**Value**	**Comment**
Purity of test substance	≥ 98%	
Concentrations measured?	Yes	
Measured is what % of nominal?	≥ 90%	
Chemical method documented?	Yes	
Concentration of carrier (if any) in test solutions	100 uL per test vessel; size of vessel NR	
Concentration 1 Nom/Meas (μg/L)	5 concentrations; levels NR	Reps: 3 w/10 per
Control	Solvent	Reps: 3 w/10 per
LC50 (95% ci); μg/L	4.3 (3.7-5.6)	Log-probit

Reliability points taken off for:
Documentation: Nominal concentrations (3), Measured concentrations (3), Dilution water (3), Hardness (2), Alkalinity (2)
Acceptability: Control response (9), Carrier solvent (4), Organisms randomized (1), Dilution water (2), Hardness (2), Alkalinity (2), Random design (2), Dilution factor (2), Hypothesis tests (3)

Jordanella floridae

Toxicity Data Summary

Allison DT, Hermanutz RO. 1977. Toxicity of diazinon to brook trout and fathead minnows. EPA-600/3-77-060. Environmental Research Laboratory-Duluth, Office of Research and Development, US Environmental Protection Agency, Duluth, MN.

Relevance	Reliability
Score: 92.5 (Control response NR)	Score: 81.5
Rating: R	Rating: R

Allison & Hermanutz 1977		
Parameter	**Value**	**Comment**
Test method cited	Acute: APHA Chronic: methods recommended by committee on aquatic bioassays, ERL-Duluth w/ noted exceptions	
Phylum	Chordata	
Class	Actinopterygii	
Order	Cyprinodontiformes	
Family	Cyprinodontidae	
Genus	*Jordanella*	
Species	*floridae*	
Found in	N. America	
Age/size at start of test/growth phase	Test 1: 6 wk, 18.1 mm Test 2: 7 wk, 17.8 mm	
Source of organisms	Lab culture	
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	Yes	
Animals randomized?	Yes	
Test vessels randomized?	NR	
Test duration	96 h	
Data for multiple times?	No	
Effect 1	Mortality	
Control response 1	NR	
Temperature	$25 \pm 0.5^{o}C$	
Test type	Flow-through	
Photoperiod/light intensity	NR	
Dilution water	Lake Superior	
pH	7.2-7.8	
Hardness	42-47 mg/L	
Alkalinity	39-44 mg/L	

Allison & Hermanutz 1977		
Parameter	**Value**	**Comment**
Conductivity	NR	
Dissolved Oxygen (range)	Acute 1: 105% (103-107) Acute 2: 103% (102-105)	
Feeding	NR	
Purity of test substance	92.5%	
Concentrations measured?	Yes	
Measured is what % of nominal?	NC	
Chemical method documented?	Yes	
Concentration of carrier (if any) in test solutions	24 mg/L (0.03 mL/L) acetone; Triton-X surfactant at 3% of diazinon concentration in both acute & chronic	Conversion to mL/L based on density of 0.785 g/mL at 25^{o} C
Concentration 1, Meas (range); mg/L	Test 1: 0.20 (0.17-0.22) Test 2: 0.68 (0.60-0.77)	Reps: Test 1: 2 w/40 per Test 2: 2 w/40 per
Concentration 2, Meas (range); mg/L	Test 1: 0.36 (0.35-0.38) Test 2: 0.92 (0.91-0.95)	Reps: Test 1: 2 w/40 per Test 2: 2 w/40 per
Concentration 3, Meas (range); mg/L	Test 1: 0.82 (0.76-0.85) Test 2: 1.3 (1.2-1.4)	Reps: Test 1: 2 w/40 per Test 2: 2 w/40 per
Concentration 4, Meas (range); mg/L	Test 1: 1.6 (1.5-1.8) Test 2: 2.1 (1.8-2.2)	Reps: Test 1: 2 w/40 per Test 2: 2 w/40 per
Concentration 5, Meas (range); mg/L	Test 1: 3.1 (2.9-3.3) Test 2: 3.0 (2.9-3.2)	Reps: Test 1: 2 w/40 per Test 2: 2 w/40 per
Control	Dilution water; solvent	Reps: Test 1: 2 w/40 per Test 2: 2 w/40 per
LC50 (95% ci); µg/L	Test 1: 1500 (1200-1900) Test 2: 1800 (1600-2000) GeoMean: 1650	Litchfield & Wilcoxon

Reliability points taken off for:
Documentation: Nominal concentrations (3), Conductivity (2), Photoperiod (3), Hypothesis tests (8)
Acceptability: Control response (9), Measured conc 20% of nominal (4), Appropriate feeding (3), Conductivity (1), Photoperiod (2), Random design (2)

Lepomis macrochirus

Toxicity Data Summary

Allison DT, Hermanutz RO. 1977. Toxicity of diazinon to brook trout and fathead minnows. EPA-600/3-77-060. Environmental Research Laboratory-Duluth, Office of Research and Development, US Environmental Protection Agency, Duluth, MN.

Relevance
Score: 92.5 (Control response NR)
Rating: R

Reliability
Score: 81.5
Rating: R

Allison & Hermanutz 1977		
Parameter	**Value**	**Comment**
Test method cited	Acute: APHA Chronic: methods recommended by committee on aquatic bioassays, ERL-Duluth w/ noted exceptions	
Phylum	Chordata	
Class	Actinopterygii	
Order	Perciformes	
Family	Centrarchidae	
Genus	*Lepomis*	
Species	*macrochirus*	
Found in	N. America	
Age/size at start of test/growth phase	Test 1:1 yr, 50 mm Test 2: 1 yr, 56.6 mm	
Source of organisms	Federal hatchery	
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	Yes	
Animals randomized?	Yes	
Test vessels randomized?	NR	
Test duration	96 h	
Data for multiple times?	No	
Effect 1	Mortality	
Control response 1	NR	
Temperature	$25 \pm 0.5^{o}C$	
Test type	Flow-through	
Photoperiod/light intensity	NR	
Dilution water	Lake Superior	
pH	7.2-7.8	
Hardness	42-47 mg/L	

Allison & Hermanutz 1977		
Parameter	**Value**	**Comment**
Alkalinity	39-44 mg/L	
Conductivity	NR	
Dissolved Oxygen (range)	Acute 1: 100% (93-103) Acute 2: 98% (88-103)	
Feeding	NR	
Purity of test substance	92.5%	
Concentrations measured?	Yes	
Measured is what % of nominal?	NC	
Chemical method documented?	Yes	
Concentration of carrier (if any) in test solutions	24 mg/L (0.03 mL/L) acetone; Triton-X surfactant at 3% of diazinon concentration in both acute & chronic	Conversion to mL/L based on density of 0.785 g/mL at 25^{o} C
Concentration 1, Meas (range); mg/L	Test 1: 0.04 (0.02-0.06) Test 2: 0.04 (0.04-0.05)	Reps: Test 1: 2 w/10 per Test 2: 2 w/20 per
Concentration 2, Meas (range); mg/L	Test 1: 0.08 (0.07-0.09) Test 2: 0.10 (0.09-0.11)	Reps: Test 1: 2 w/10 per Test 2: 2 w/20 per
Concentration 3, Meas (range); mg/L	Test 1: 0.22 (0.21-0.23) Test 2: 0.22 (0.21-0.24)	Reps: Test 1: 2 w/10 per Test 2: 2 w/20 per
Concentration 4, Meas (range); mg/L	Test 1: 0.44 (0.43-0.45) Test 2: 0.44 (0.38-0.47)	Reps: Test 1: 2 w/10 per Test 2: 2 w/20 per
Concentration 5, Meas (range); mg/L	Test 1: 0.89 (0.86-0.93) Test 2: 0.80 (0.69-0.88)	Reps: Test 1: 2 w/10 per Test 2: 2 w/20 per
Control	Dilution water; solvent	Reps: Test 1: 2 w/10 per Test 2: 2 w/20 per
LC50 (95% ci); µg/L	Test 1: 480 (340-670) Test 2: 440 (310-620) GeoMean: 460	Litchfield & Wilcoxon

Reliability points taken off for:
Documentation: Nominal concentrations (3), Conductivity (2), Photoperiod (3), Hypothesis tests (8)
Acceptability: Control response (9), Measured conc 20% of nominal (4), Appropriate feeding (3), Conductivity (1), Photoperiod (2), Random design (2)

Neomysis mercedis

Toxicity Data Summary

Study: CDFG. 1992c. Test No. 162. 96-h acute toxicity of diazinon to *Neomysis mercedis*, Aquatic Toxicity Laboratory, Elk Grove, CA.

Relevance
Score: 100
Rating: R

Reliability
Score: 93
Rating: R

CDFG No. 162 1992c		
Parameter	**Value**	**Comment**
Test method cited	ASTM 1988 (E729-88)	
Phylum/subphylum	Arthropoda/crustacean	
Class	Malacostraca	
Order	Mysidacea	
Family	Mysidae	
Genus	*Neomysis*	
Species	*mercedis*	
Found in	N. Amer.	
Age/size at start of test	< 5 d post-release	
Source of organisms	Lab culture	
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	Yes	
Animals randomized?	Yes	
Test vessels randomized?	Yes	
Test duration	96 h	
Data for multiple times?	Yes; see study	
Effect 1	Mortality	
Control response 1	Dilution water: 0% Solvent: 5% Total: 2.5%	
Temperature; mean	17^{o} C	
Test type	Static renewal; daily renewal	
Photoperiod	16L:8D	
Dilution water	Aquat Tox Lab well water plus 2 g/kg artificial sea salt	
pH; mean	8.33	
Hardness; mean	457 mg/L as $CaCO_3$	
Alkalinity; mean	150 mg/L as $CaCO_3$	

CDFG No. 162 1992c		
Parameter	**Value**	**Comment**
Conductivity; mean	3003 uS/cm	
Dissolved Oxygen; mean	8.71 mg/L	
Feeding	Artemia nauplii; frequency NR	
Purity of test substance	88%	
Concentrations measured?	Yes	
Measured is what % of nominal?	100%	
Chemical method documented?	Yes	
Concentration of carrier (if any) in test solutions	$\leq$ 0.208 mL/L triethylene glycol/ triethylene glycol dimethyl ether	
Concentration 1 Meas (μg/L)	0.48	Reps: 20 w/1 per
Concentration 2 Meas (μg/L)	1.01	Reps: 20 w/1 per
Concentration 3 Meas (μg/L)	2.10	Reps: 20 w/1 per
Concentration 4 Meas (μg/L)	4.15	Reps: 20 w/1 per
Concentration 5 Meas (μg/L)	8.32	Reps: 20 w/1 per
Control	< 0.02 ug/L diazinon; dilution water; solvent	Reps: 20 w/1 per
LC50 (95% ci); ug/L	3.57 (2.99-4.36)	Moving average
NOEC; ug/L	2.10	Chi squared
LOEC; ug/L	4.15	
MATC (GeoMean NOEC,LOEC)	2.95	
% of control at NOEC	Dilution: 95% Solvent: 100%	
% of control at LOEC	Dilution: 35% Solvent: 36.8%	

Reliability points taken off for:
Documentation: Nominal concentrations (3), Significance level (2), Minimum significant difference (2)
Acceptability: Appropriate feeding (3), Temperature > +/- 1 ^{o}C (3), Minimum significant difference (1)

Neomysis mercedis

Toxicity Data Summary

Study: CDFG. 1992d. Test No. 168. 96-h acute toxicity of diazinon to *Neomysis mercedis*. Aquatic Toxicology Laboratory, Elk Grove, CA.

Relevance	Reliability
Score: 100	Score: 93
Rating: R	Rating: R

CDFG No. 168 1992d		
Parameter	**Value**	**Comment**
Test method cited	ASTM 1988 (E729-88)	
Phylum/subphylum	Arthropoda/crustacea	
Class	Malacostraca	
Order	Mysidacea	
Family	Mysidae	
Genus	*Neomysis*	
Species	*mercedis*	
Found in	N. Amer.	
Age/size at start of test	< 5 d post-release	
Source of organisms	Lab culture	
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	Yes	
Animals randomized?	Yes	
Test vessels randomized?	Yes	
Test duration	96 h	
Data for multiple times?	Yes; see original paper	
Effect 1	Mortality/immobility	
Control response 1	0%	
Temperature; mean (range); ^{o}C	17.49 (16.7-19.0)	
Test type	Static renewal; daily renewal	
Photoperiod	16L:8D	
Dilution water	Aquatic Tox Lab well water with 2 g/kg artificial sea salt	
pH	8.36 (7.98-8.48)	
Hardness; mean (range); mg/L $CaCO_3$	465 (446-476)	
Alkalinity; mean (range); mg/L $CaCO_3$	145 (144-148)	
Conductivity; mean (range); uS/cm	2900 (2800-3100)	

CDFG No. 168 1992d		
Parameter	**Value**	**Comment**
Dissolved Oxygen; mean (range); mg/L	8.92 (8.33-9.81)	
Feeding	Artemia nauplii (frequency NR)	
Purity of test substance	88%	
Concentrations measured?	Yes	
Measured is what % of nominal?	95.5%	
Chemical method documented?	Yes	
Concentration of carrier (if any) in test solutions	0.12 mL/L triethylene glycol/triethylene dimethyl glycol	
Concentration 1 Meas (µg/L)	0.57	Reps: 10 w/1 per
Concentration 2 Meas (µg/L)	1.2	Reps: 10 w/1 per
Concentration 3 Meas (µg/L)	2.45	Reps: 10 w/1 per
Concentration 4 Meas (µg/L)	4.5	Reps: 10 w/1 per
Concentration 5 Meas (ug/L)	8.9	Reps: 10 w/1 per
Control	Dilution water; solvent control	Reps: 10 w/1 per; Measured 0.02 ug/L diazinon in solvent control)
LC50 (95% ci); ug/L	4.82 (3.95-6.00)	Moving average
NOEC; ug/L	2.45	Chi square
LOEC; indicate calculation method	4.5	
MATC (GeoMean NOEC,LOEC)	3.32	
% of control at NOEC	100%	
% of control at LOEC	60%	

Reliability points taken off for:
Documentation: Nominal concentrations (3), Significance level (2), Minimum significant difference (2)
Acceptability: Appropriate feeding (3), Temperature > +/- 1^{o}C (3), Minimum significant difference (1)

Physa sp. (pond snail)

Toxicity Data Summary

Study: CDFG. 1998b. Test 132. 96-h toxicity of diazinon to *Physa* sp. Aquatic Toxicology Laboratory, Elk Grove, California.

Relevance	Reliability
Score: 100	Score: 94
Rating: R	Rating: R

CDFG No. 132 1998b		
Parameter	**Value**	**Comment**
Test method cited	ASTM 1988 (E729-88 and E1192-88)	
Phylum	Mollusca	
Class	Gastropoda	
Order	Basommatophera	
Family	Physidae	
Genus	*Physa*	
Species	sp.	
Found in	N. Amer.	
Age/size at start of test	Juvenile	
Source of organisms	Mass culture ponds	
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	Yes	
Animals randomized?	Yes	
Test vessels randomized?	Yes	
Test duration	96 h	
Data for multiple times?	Yes; see original study	
Effect 1	Mortality	
Control response 1	5%	
Temperature; mean (range); ^oC	Control: 21.7 (21.0-22.4) Test: 21.6 (21.0-22.1)	Measured in highest test concentration
Test type	Static; daily renewal	
Photoperiod	16L:8D	
Dilution water	Aquatic Tox Lab well water	
pH; mean (range)	Control: 7.43 (6.72-8.18) Test: 7.82 (7.31-8.31)	
Hardness; mean (range); mg/L $CaCO_3$	Control: 110 Test: 122	
Alkalinity; mean (range); mg/L $CaCO_3$	Control: 132 Test: 132	

CDFG No. 132 1998b		
Parameter	**Value**	**Comment**
Conductivity; mean (range); mS/cm	Control: 271 (243-299) Test: 257 (250-263)	
Dissolved Oxygen; mean (range); mg/L	Control: 6.47 (4.12-8.81) Test: 7.09 (3.92-9.05)	
Feeding	None	
Purity of test substance	87% (technical)	
Concentrations measured?	Yes	
Measured is what % of nominal?	48%, but stats based on measured values	
Chemical method documented?	Yes	
Concentration of carrier (if any) in test solutions	None used	
Concentration 1 Meas (**m**g/L)	0.55	Reps: 10 w/2 per
Concentration 2 Meas (**m**g/L)	1.1	Reps: 10 w/2 per
Concentration 3 Meas (**m**g/L)	2.16	Reps: 10 w/2 per
Concentration 4 Meas (**m**g/L)	3.94	Reps: 10 w/2 per
Concentration 5 Meas (**m**g/L)	7.50	Reps: 10 w/2 per
Control	Dilution water	Reps: 10 w/2 per
LC50; mg/L	4.41 mg/L	Non-linear interpolation
NOEC; mg/L	2.16	Chi square
LOEC; mg/L	3.94	
MATC (GeoMean NOEC,LOEC); mg/L	2.92	
% of control at NOEC	95%	
% of control at LOEC	68%	

Reliability points taken off for:
<u>Documentation:</u> Nominal concentrations (3), Significance level (2), Minimum significant difference (2)
<u>Acceptability:</u> Measured conc w/in 20% nominal (4), Minimum significant difference (1)

Pimephales promelas

Toxicity Data Summary

Allison DT, Hermanutz RO. 1977. Toxicity of diazinon to brook trout and fathead minnows. EPA-600/3-77-060. Environmental Research Laboratory-Duluth, Office of Research and Development, US Environmental Protection Agency, Duluth, MN.

Relevance
Score: Chronic: 100
Acute 92.5 (control response NR)
Rating: R

Reliability
Score: Chronic: 90
Acute 81
Rating: R

Allison & Hermanutz 1977		
Parameter	**Value**	**Comment**
Test method cited	Acute: APHA Chronic: methods recommended by committee on aquatic bioassays, ERL-Duluth w/ noted exceptions	
Phylum	Chordata	
Class	Actinopterygii	
Order	Cypriniformes	
Family	Cyprinidae	
Genus	*Pimephales*	
Species	*promelas*	
Found in	North America	
Age/size at start of test/growth phase	Acute 1: 15-wk Acute 2: 20-wk Acute 3: 13-wk Chronic 1: 4-d Chronic 2: 5-d	
Source of organisms	Lab culture	
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	Yes	
Animals randomized?	Yes	
Test vessels randomized?	NR	
Test duration	Acute: 96 h Chronic: 274 d (longest)	
Data for multiple times?	Yes	
Effects	See below	
Control responses	See below	
Temperature	Acute: 25 $\pm$ 1^{o}C Chronic adult: 25 $\pm$ 1^{o} C	

Allison & Hermanutz 1977		
Parameter	**Value**	**Comment**
	Chronic larval: 25.5 $\pm$ 1^o C	
Test type	Flow-through	
Photoperiod/light intensity	Acute: NR Chronic: Evansville, IN; variable for life cycle	
Dilution water	Lake Superior	
pH	Acute: within chronic test Chronic 7.5 (7.2-7.8)	
Hardness	Acute: within chronic test Chronic: 44 (42-47) mg/L	
Alkalinity	Acute: within chronic test Chronic: 42 (39-44) mg/L	
Conductivity	Acute: NR Chronic: NR	
Dissolved Oxygen (range)	Acute 1: 105% (95-115) Acute 2: 96% (87-101) Acute 3: 104% (100-108) Chronic: 85% (74-107)	
Feeding	Acute: NR Chronic: daily	
Purity of test substance	92.5%	
Concentrations measured?	Yes	
Measured is what % of nominal? (range)	Acute: NC Chronic: 108% (91-122)	
Chemical method documented?	Yes	
Concentration of carrier (if any) in test solutions	Acute: 24 mg/L (0.03 mL/L) acetone; Chronic: 2 mg/L (0.002mL/L) acetone; Triton-X surfactant at 3% of diazinon concentration in both acute & chronic	Conversion to mL/L based on density of 0.785 g/mL at 25^o C
Concentration 1 Acute: Meas (range); mg/L Chronic: Nom/Meas; µg/L	Acute 1: 1.1 (1.0-1.1) Acute 2: 1.1 (0.9-1.2) Acute 3: 1.7 (1.4-1.9) Chronic 1 adult: 62.5/69 Chronic 2 adult: 3.9/3.2 Chronic 2 larval: 3.9/3.3	Reps: Acute: 2 w/20 per Chronic: 2 w/50 per; thinned to 15 fish at 61 d (test 1) and 167 d (test 2)
Concentration 2 Acute: Meas (range); mg/L Chronic: Nom/Meas; µg/L	Acute 1: 2.1 (1.9-2.3) Acute 2: 1.9 (1.7-2.1) Acute 3: 2.3 (2.1-2.6) Chronic 1 adult: 125/118 Chronic 2 adult: 7.8/6.9 Chronic 2 larval: 7.8/6.8	Reps: Acute: 2 w/20 per Chronic: 2 w/50 per; thinned to 15 fish at 61 d (test 1) and 167 d (test 2)

Allison & Hermanutz 1977		
Parameter	**Value**	**Comment**
Concentration 3 Acute: Meas (range); mg/L Chronic: Nom/Meas; µg/L	Acute 1: 3.4 (3.2-3.7) Acute 2: 3.4 (2.9-3.8) Acute 3: 3.0 (2.6-3.4) Chronic 1 adult: 250/229 Chronic 2 adult: 15.6/13.5 Chronic 2 larval: not done	Reps: Acute: 2 w/20 per Chronic: 2 w/50 per; thinned to 15 fish at 61 d (test 1) and 167 d (test 2)
Concentration 4 Acute: Meas (range); mg/L Chronic: Nom/Meas; µg/L	Acute 1: 6.0 (5.6-6.5) Acute 2: 4.9 (4.3-5.9) Acute 3: 4.1 (3.6-4.7) Chronic 1 adult: 500/511 Chronic 2 adult: 31.2/28.0 Chronic 2 larval: 31.2/ 28.0	Reps: Acute: 2 w/20 per Chronic: 2 w/50 per; thinned to 15 fish at 61 d (test 1) and 167 d (test 2)
Concentration 5 Acute: Meas (range); mg/L Chronic: Nom/Meas; µg/L	Acute 1: 11.7 (11.0-12.6) Acute 2: 10.6 (8.6-12.3) Acute 3: 7.9 (7.4-8.6) Chronic 1 adult: 1000/1099 Chronic 2 adult: 62.5/60.3 Chronic 2 larval: 62.5/62.6	Reps: Acute: 2 w/20 per Chronic: 2 w/50 per; thinned to 15 fish at 61 d (test 1) and 167 d (test 2)
Control	Dilution water; solvent	Reps: Acute: 2 w/20 per Chronic: 2 w/50 per; thinned to 15 fish at 61 d (test 1) and 167 d (test 2)
LC50; µg/L	Test 1: 6800 Test 2: 6600 Test 3: 10000 GeoMean: 7800	Litchfield & Wilcoxon
NOEC; µg/L	See below	See below

ACR based on geometric mean LC50 from this test and 167-274-d survival:
LC50/MATC = 7800/41 = 190

Acute control survival NR, but standard method followed.

NOEC/LOEC (µg/L) determined by ANOVA, Dunnett's; p = 0.05; MSD NR.

<u>Test 1: Survival at 30 d</u>
NOEC = 1100 (160% of control)
LOEC = > 1100
MATC = NC
Control response: 47%

Test 1: Average total length at 30 d
NOEC = 1100 (78% of control)
LOEC = > 1100
MATC = NC
Control response: 11.1 mm

Test 1: Survival at 61 d
NOEC = 1100 (126% of control)
LOEC = > 1100
MATC = NC
Control response: 38%

Test 1: Average total length
NOEC = 1100 (62% of control)
LOEC = > 1100
MATC = NC
Control response: 19.8 mm

Test 1: Instantaneous growth rate
NOEC = 69 (93% of control)
LOEC = 229 (62% of control)
MATC = 200
Control response: 188 d^{-1}

Test 1: Incidence of scoliosis at 13 wk
NOEC = < 69
LOEC = 69 (860% of control)
MATC = NC
Control response: 7%

Test 2: Incidence of scoliosis at 19 wk Not linked to survival, growth, reproduction
NOEC = 6.9 (137% of control)
LOEC = 13.5 (210% of control)
MATC = 9.7
Control response: 19%

Test 2: Incidence of scoliosis at 24 wk (interrupted dose response)
NOEC = < 3.2
LOEC = 3.2 (162% of control)
MATC = NC
Control response: 21%

Test 2
No significant effects on survival, growth or instantaneous growth of parents rate at 31, 64, 97, 135, 167 d. No significant effects on number of mature females at termination, number of spawnings, total number of eggs, eggs/spawning, eggs/female, estimated larvae/female, mature males, mature females, mature males and females, 30- and 60-d progeny survival, 30- and 60-d progeny average total length, 30- and 60-d progeny average weight.

Test 2: Survival from 167-274 d *********Use this result **********
NOEC = 28.0 (86% of control)
LOEC = 60.3 (54% of control)
MATC = 41
Control response: 93%

Test 2: Hatchability
NOEC = < 3.2
LOEC = 3.2 (71% of control)
MATC = NC
Control response: 92%

Reliability points taken off for:
Documentation: Nominal concentrations (3 - acute only), Conductivity (3), Photoperiod (3 – acute only), Hypothesis tests (8 – acute only), Minimum significant difference (2 – chronic only), Point estimates (8 – chronic only)
Acceptability: Control response (9 – acute only), Appropriate feeding (3 – acute only), Conductivity (1), Photoperiod (2 – acute only), Random design (2), Hypothesis tests (3 – acute only), Minimum significant difference (1 – chronic only), Point estimates (3 – chronic only)

Pimephales promelas

Toxicity Data Summary

Denton DL, Wheelock CE, Murray SH, Deanovic LA, Hammock BD, Hinton DE. 2003. Joint acute toxicity of esfenvalerate and diazinon to larval fathead minnows (*Pimephales promelas*). *Environ Toxicol Chem* 22: 336-341.

Relevance	Reliability
Score: Mortality: 100; Sublethal 60 (No Std. Method, Endpoint, No values)	Score: 80 (Mortality)
Rating: R (Mortality); N (Sublethal)	Rating: R

Denton *et al.* 2003		
Parameter	**Value**	**Comment**
Test method cited	USEPA 1993 acute	
Phylum	Chordata	
Class	Actinopterygii	
Order	Cypriniformes	
Family	Cyprinidae	
Genus	*Pimephales*	
Species	*promelas*	
Found in	North America	
Age/size at start of test/growth phase	7 d	
Source of organisms	Certified supplier	
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	Yes	
Animals randomized?	NR	
Test vessels randomized?	NR	
Test duration	96 h	
Data for multiple times?	No	
Effect 1	Mortality	
Control response 1	$\leq$ 10%	
Effect 2	Carboxylesterase activity	
Control response 2	Baseline	
Effect 3	Acetylcholinesterase activity	
Control response 3	Baseline	
Temperature	20^{o} C	
Test type	Static renewal	
Photoperiod/light intensity	NR	
Dilution water	Synthetic moderately hard	

Denton *et al.* 2003		
Parameter	**Value**	**Comment**
	water	
pH	Within guidelines	
Hardness	Meets dilution water specs	
Alkalinity	Meets dilution water specs	
Conductivity	Within guidelines	
Dissolved Oxygen	Within guidelines	
Feeding	2 h before start of test; 2 h before each renewal	
Purity of test substance	99.4%	
Concentrations measured?	Yes	
Measured is what % of nominal?	57-100%	
Chemical method documented?	Yes	
Concentration of carrier (if any) in test solutions	< 0.5 mL/L	
Concentration 1 Nom/Meas (μg/L)	Number and levels NR	Reps: 3 w/10 per
Control	solvent	
LC50; μg/L	Test 1: 6393 Test 2: 5048 Test 3: 7969 GeoMean: 6470	probit

No toxicity values were generated for carboxylesterase and acetylcholinesterase activity. Some diazinon effects were seen, but no statistical analysis was done to determine significance. These endpoints are not linked to survival, growth or reproduction (analysis was done only on animals surviving to end of test).

Reliability points taken off for:
Documentation: Nominal concentrations (3), Measured concentrations (3), Photoperiod (3), Hypothesis tests (8)
Acceptability: Measured conc w/in 20% of nominal (4), Organisms randomized (1), Appropriate feeding (3), Temperature > +/- 1^{o}C (3), Photoperiod (2), Number of concentrations (3), Random design (2), Dilution factor (2), Hypothesis tests (3)

Pimephales promelas

Toxicity Data Summary

Study: Geiger DL, Call DJ, Brooke LT. 1988. Acute toxicities of organic chemicals to fathead minnows (*Pimephales promelas*). Center for Lake Superior Environmental Studies, University of Wisconsin-Superior. Pp279-280.

Relevance-mortality
Score: 90 (No standard method)
Rating: R

Relevance—sublethal effects
Score: 75 (No standard method; Endpoints not linked to survival, growth, reproduction)
Rating: L

Reliability -- mortality & sublethal effects
Score: 86
Rating: R

Geiger *et al.* 1988		
Parameter	**Value**	**Comment**
Test method cited	No standard method cited	
Phylum	Chordata	
Class	Actinopterygii	
Order	Cypriniformes	
Family	Cyprinidae	
Genus	*Pimephales*	
Species	*promelas*	
Found in	N. Amer.	
Age/size at start of test/growth phase	31 d	
Source of organisms	Lab culture	
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	Yes	
Animals randomized?	Yes	
Test vessels randomized?	NR	
Test duration	96 h	
Data for multiple times?	Yes, see below	
Effect 1	Mortality	
Control response 1	0%	
Effect 2	Loss of equilibrium	
Control response 2	0% affected fish	
Temperature	24.5 $\pm$ 0.32	

Geiger *et al.* 1988		
Parameter	**Value**	**Comment**
Test type	Flow-through	
Photoperiod/light intensity	NR	
Dilution water	Lake Superior or dechlorinated tapwater (waters shown to be very similar)	
pH	7.6 ± 0.05	
Hardness	43.6 mg/L as $CaCO_3$	
Alkalinity	42.6 mg/L as $CaCO_3$	
Conductivity	NR	
Dissolved Oxygen	6.6 ± 0.49	
Feeding	None	
Purity of test substance	87.1	
Concentrations measured?	Yes	
Measured is what % of nominal?	78-92%	
Chemical method documented?	Yes	
Concentration of carrier (if any) in test solutions	None used	
Concentration 1 Nom/Meas (mg/L)	3.35/2.61 (A)	Reps: 1 w/20 per
Concentration 2 Nom/Meas (mg/L)	5.15/4.43 (B)	Reps: 1 w/20 per
Concentration 3 Nom/Meas (mg/L)	7.93/6.80 (C)	Reps: 1 w/20 per
Concentration 4 Nom/Meas (mg/L)	12.2/10.1 (D)	Reps: 1 w/20 per
Concentration 5 Nom/Meas (mg/L)	18.8/17.2 (E)	Reps: 1 w/20 per
Control	Dilution water	Reps: 1 w/20 per
LC50 (95% ci); mg/L	9.35 (8.12-10.8)	Trimmed Spearman-Karber
EC50 (95% ci); mg/L	7.46 (6.67-8.34)	Trimmed Spearman-Karber

Mortalities by concentration and day (20 fish per concentrations at start):

	Control	A	B	C	D	E
24 h	0	0	0	2	5	16
48 h	0	0	0	4	9	18
72 h	0	0	0	4	10	18
96 h	0	0	0	4	12	19

Reliability points taken off for:
Documentation: Conductivity (2), Photoperiod (3), Hypothesis tests (8)
Acceptability: No standard method (5), Conductivity (1), Photoperiod (2), Random design (2), Adequate replicates (2), Hypothesis tests (3)

Pimephales promelas

Toxicity Data Summary

Study: Jarvinen AW, Tanner DK. 1982. Toxicity of selected controlled release and corresponding unformulated technical grade pesticides to the fathead minnow *Pimephales promelas*. Environ Poll (Series A). 27: 179-195.

Relevance
Score: Acute: 92.5 (Control response NR);
Chronic: 100
Rating: R (both)

Reliability
Score: Acute: 78; Chronic: 86
Rating: R

Jarvinen & Tanner 1982		
Parameter	**Value**	**Comment**
Test method cited	USEPA 1975 (acute studies); ERL Duluth 1979 (embryo-larval)	
Phylum	Chordata	
Class	Actinopterygii	
Order	Cyriniformes	
Family	Cyprinidae	
Genus	*Pimephales*	
Species	*promelas*	
Native to	North America	
Age/size at start of test	Newly hatched (4-d tests); Newly hatched (embryo-larval)	
Test duration	96-h static; 96-h flow-through acute; 32-d flow-through embryo-larval	
Data for multiple times?	No	
Effect 1	Mortality (static and FT)	
Control response 1	Acute: NR; 32-d exposure: 0%	
Effect 2	Weight	
Control response 2		
Temperature	23.5-26.0 ^{o}C	
Test type	Static (pyrex beakers) Flow-through	Flow-through at 15 ml/min; 99% replacement in 3 h
Photoperiod	16L:8D	
Dilution water	Lake Superior; sand-filtered, sterilized	
pH	7.4-7.8	

Jarvinen & Tanner 1982		
Parameter	**Value**	**Comment**
Hardness	45.8 mg/L	
Alkalinity	43.1 mg/L	
Salinity	NA	
Dissolved Oxygen	Flow-through: > 75% saturation; 6.5-8.4 mg/L in all	
Feeding	Acute: not mentioned; 32-d: 2-3 X daily (nauplii)	
Purity of test substance	Technical: 87.1%; Knox Out 2 FM: 23%	
Concentrations measured?	Yes	
Concentration 1 Meas (**m**g/L)	Acute studies: NR Chronic technical: 0.05 ± 0.01; Chronic Knox Out: 0.04 ± 0.05	Reps: Static: 2 w/10 per; 4-d FT: 2 w/20 per; 32-d FT: 2 w/15 per
Concentration 2 Meas (**m**g/L)	Acute studies: NR Chronic technical: 0.09 ± 0.02 Chronic Knox Out: 0.076 ± 0.006	Reps: Static: 2 w/10 per; 4-d FT: 2 w/20 per; 32-d FT: 2 w/15 per
Concentration 3 Meas (**m**g/L)	Acute studies: NR Chronic technical: 0.14 ± 0.01; Chronic Knox Out: 0.125 ± 0.01	Reps: Static: 2 w/10 per; 4-d FT: 2 w/20 per; 32-d FT: 2 w/15 per
Concentration 4 Meas (**m**g/L)	Acute studies: NR Chronic technical: 0.29 ± 0.03; Chronic Knox Out: 0.26 ± 0.03	Reps: Static: 2 w/10 per; 4-d FT: 2 w/20 per; 32-d FT: 2 w/15 per
Concentration 5 Meas (**m**g/L)	Acute studies: NR Chronic technical: 0.50 ± 0.06; Chronic Knox Out: 0.49 ± 0.07	Reps: Static: 2 w/10 per; 4-d FT: 2 w/20 per; 32-d FT: 2 w/15 per
Control?	0.00007-0.0001 mg/L; no carriers	Reps: Static: 2 w/10 per; 4-d FT: 2 w/20 per; 32-d FT: 2 w/15 per
LC50 (95% ci); **m**g/L	Static, 96-h, technical, un-aged: 4.3 (3.4- 5.2); Static, 96-h, technical, aged: 2.1 (1.7-2.9);	Moving average

Jarvinen & Tanner 1982		
Parameter	**Value**	**Comment**
	Static, 96-h, Knox, un-aged: 6.1 (5.0-7.6); Static, 96-h, Knox, aged: 5.1 (4.4-6.1); FT, 96-h, technical: 6.9 (6.2-7.9); FT, 96-h, Knox: NC (not enough mortality)	
NOEC; (32-d FT); **m**g/L	Survival, technical: 0.14; Weight, technical: 0.05; Survival, Knox: 0.26; Weight, Knox: 0.04	ANOVA; Dunnett's
LOEC; **m**g/L	Survival, technical: 0.29; Weight, technical: 0.09; Survival, Knox: 0.49; Weight, Knox: 0.076	
MATC (GeoMean NOEC,LOEC)	Survival, technical: 0.20; Weight, technical: 0.067; Survival, Knox: 0.36; Weight, Knox: 0.055	
% of control at NOEC	Survival, technical: 93.3%; Weight, technical: 90.4%; Survival, Knox: 100%; Weight, Knox: 93.2%	
% of control at LOEC	Survival, technical: 63.4%; Weight, technical: 89.9%; Survival, Knox: 83.4%; Weight, Knox: 88.9%	

Other data:

Stock toxicant solutions were made using a saturator system; acute static tests were done weekly over an 11 week period to see if toxicity changed as solutions aged.

Water solubility of technical diazinon: 40 mg/L
Water solubility of Knox Out: 34 mg/L

$t_{1/2}$ = 30 d for technical grade; determined in static half-life studies using Lake Superior water separate from tox studies
$t_{1/2}$ = > 230 d for Knox Out

Text clearly says that embryo-larval exposures were started with larvae; doesn't make sense, but that's what it says.

LC50s for STATIC tests

2.1 (aged)   *** use this value ******
4.3 (new)

Reliability points taken off for:
Documentation: Nominal concentrations (3), Measured concentrations (3 – acute only), Conductivity (2), Hypothesis tests (8 – acute only), Significance level (2 – chronic only), Minimum significant difference (2 – chronic only), Point estimates (8 – chronic only)
Acceptability: Control response (9 – acute only), Measured conc w/in 20% of nominal (4), Appropriate feeding (3 – acute only), Conductivity (1), Number of concentrations (3 – acute only), Random design (2), Adequate replicates (2 – acute only), Hypothesis tests (3 – acute only), Minimum significant difference (1 – chronic only), Point estimates (3 – chronic only)

Pimephales promelas

Toxicity Data Summary

Surprenant DC. 1988b. The toxicity of diazinon technical to fathead minnow (*Pimephales promelas*) embryos and larvae. Agricultural Division, Ciba-Geigy Corporation, Greensboro, NC.

Chronic only

Relevance
Score: 100
Rating: R

Reliability
Score: 93.5
Rating: R

Surprenant 1988b		
Parameter	**Value**	**Comment**
Test method cited	USEPA 1981; ASTM 1986	References below
Phylum	Chordata	
Class	Actinopterygii	
Order	Cyriniformes	
Family	Cyprinidae	
Genus	*Pimephales*	
Species	*promelas*	
Found in	N. America	
Age/size at start of test	Embryo	
Source of organisms	Lab culture	
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	Yes	
Animals randomized?	Yes	
Test vessels randomized?	NR	
Test duration	34 d	
Data for multiple times?	No	
Effect 1	Survival at hatch	No significant effects seen
Control response 1	81%	
Effect 2	Larval survival	No significant effects seen
Control response 2	94%	
Effect 3	Larval growth (weight)	
Control response 3	129 mg	
Effect 4	Larval growth (length)	
Control response 4	25 mm	
Temperature	25 ± 0.5^{o} C	
Test type	Flow-through	
Photoperiod/light intensity	16L:8D	

Surprenant 1988b		
Parameter	**Value**	**Comment**
Dilution water	Well water	
pH	6.8-7.5	
Hardness	29-30 mg/L as $CaCO_3$	
Alkalinity	26-27 mg/L as $CaCO_3$	
Conductivity	120-150 μmhos/cm	
Dissolved Oxygen	7.9-8.6 mg/L	
Feeding	Larvae: brine shrimp 2-3x daily;	
Purity of test substance	Technical; 87.7%	
Concentrations measured?	Yes	
Measured is what % of nominal?	99%	
Chemical method documented?	Yes	
Concentration of carrier (if any) in test solutions	0.018 mL/L	
Concentration 1 Nom/Meas (mg/L)	0.094/0.092	Reps: 2 w/60 embryos per; 40 larvae carried thru
Concentration 2 Nom/Meas (mg/L)	0.19/0.17	Same as above
Concentration 3 Nom/Meas (mg/L)	0.38/0.38	Same as above
Concentration 4 Nom/Meas (mg/L)	0.75/0.76	Same as above
Concentration 5 Nom/Meas (mg/L)	1.5/1.6	Same as above
Control	Dilution water; solvent	Same as above
NOEC; mg/L; length endpoint	0.092	Method: ANOVA, Dunnett's p: 0.05 MSD: 1.6 mm
LOEC; mg/L	0.17	Length endpoint
MATC mg/L (GeoMean NOEC,LOEC)	0.13	Length endpoint
% control at NOEC	96%	
% of control LOEC	88%	

ASTM 1985. Proposed new standard guide for conducting early life-stage toxicity tests with fishes. ASTM Committee E-47 on Biological Effects and environmental Fate, Draft No. 10, July, 1986. American Society for Testing and Materials, Conshohocken, PA.

USEPA. 1981. Recommended bioassay procedures for fathead minnows (*Pimephales promelas*) chronic tests. Bioassay Committee of the National Water Quality Laboratory, EPA/ERL Duluth, MN.

Reliability points taken off for:
Documentation: Point estimates (8)
Acceptability: Random design (2), Point estimates (3)

Pomacea paludosa

Toxicity Data Summary

Study: Call DJ (1993) Validation study of a protocol for testing the acute toxicity of pesticides to invertebrates using the apple snail (Pomacea paludosa).

Relevance
Score: 100
Rating: R

Reliability
Score: 80.5
Rating: R

Call 1993		
Parameter	**Value**	**Comment**
Test method cited	OPP methods	draft protocol
Phylum	Mollusca	
Class	Gastropoda	
Order	Architaenioglossa	
Family	Ampullariidae	
Genus	*Pomacea*	
Species	*paludosa*	
Family in North America?	Yes	
Age/size at start of test/growth phase	Test 1 - 1d, Test 2 - 7 d Test 3 - 7 d	
Source of organisms	eggs collected in Florida	
Have organisms been exposed to contaminants?	Probably not	
Animals acclimated and disease-free?	yes	
Animals randomized?	NR	
Test vessels randomized?	NR	
Test duration	96 h	
Data for multiple times?	yes	
Effect 1	Mortality (3 tests)	
Control response 1	5%, 0%, 0%	
Temperature	27.4, 26.0, 26.3	
Test type	FT	
Photoperiod/light intensity	NR	
Dilution water	Dechlorinated city amended with salts to 180mg/L	
pH	NR	
Hardness	180mg/L	
Alkalinity	NR	
Conductivity	NR	
Dissolved Oxygen	78-97%, 74-99%, 66-100	
Feeding	no	

Call 1993		
Parameter	**Value**	**Comment**
Purity of test substance	87%	
Concentrations measured?	Yes	
Measured is what % of nominal?	93-97%	
Chemical method documented?	Yes	
Concentration of carrier (if any) in test solutions	0.044ml/L	
Concentration 1 Nom/Meas (μg/L)	254, 367, 510	2 Reps of 10
Concentration 2 Nom/Meas (μg/L)	653, 711, 1080	2 Reps of 10
Concentration 3 Nom/Meas (μg/L)	1490, 1280, 1760	2 Reps of 10
Concentration 4 Nom/Meas (μg/L)	3700, 3450, 4050	2 Reps of 10
Concentration 5 Nom/Meas (μg/L)	7070, 7490, 7340	2 Reps of 10
Control	Yes	2 Reps of 10
LC50; indicate calculation method	Test 1 = 2950 Test 2 = 3270 Test 3 = 3390 Trimmed Spearman-Karber	
ECx; indicate calculation method	NR	
NOEC; indicate calculation method, significance level (p-value) and minimum significant difference (MSD)	NR	Method: p: MSD:
LOEC; indicate calculation method	NR	
MATC (GeoMean NOEC, LOEC)	NR	
% control at NOEC	NR	
% of control LOEC	NR	

Other notes:
3 tests with different ages a beginning of test: 1 day old, 7 day old, 7 day old a second time. Document obtained from EPA. Appendix missing, may contain parameters like hardness etc.

Reliability points taken off for:
Documentation: Alkalinity (2), Conductivity (2), pH (3), Photoperiod (3), Hypothesis tests (8)
Acceptability: Organisms randomized (1), Alkalinity (2), Appropriate temperature (6), Conductivity (1), pH (2), Photoperiod (2), Random design (2), Dilution factor (2), Hypothesis tests (3)

Procloeon sp.

Toxicity Data Summary

Study: Anderson BS, Phillips BM, Hunt JW, Connor V, Richard N, Tjeerdema RS. 2006. Identifying primary stressors impacting macroinvertebrates in the Salinas River (California, USA): Relative effects of pesticides and suspended particles. Environ Poll 141: 402-408.

Relevance
Score: 100 for Test 1; 92.5 for Test 2; and Test 3 (control survival <90%)
Rating: R

Reliability
Score: Test 1: 88.5; Test 2: 84; Test 3: 82.5
Rating: all: R

Anderson et al. 2006		
Parameter	**Value**	**Comment**
Test method cited	USEPA 1993	Pers. comm.
Phylum	Arthropoda	
Class	Insecta	
Order	Ephemeroptera	
Family	Baetidae	
Genus	*Procloeon*	
Species	sp.	
Found in	N. America	
Age/size at start of test/growth phase	0.5-1cm (age unknown)	
Source of organisms	Field collected from clean site	
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	Yes	
Animals randomized?	NR	
Test vessels randomized?	NR	
Test duration	48 h	
Data for multiple times?	No	
Effect 1	Mortality	
Control response 1	Dilution water: 80-84% MeOH: 84-100%	Pers. comm.
Temperature	22.1°C	From data sheet
Test type	Static renewal; daily	
Photoperiod/light intensity	NR	
Dilution water	Well water	

Anderson et al. 2006		
Parameter	**Value**	**Comment**
pH	7.4-8.1	From data sheet
Hardness	NR	
Alkalinity	NR	
Conductivity	670-682 μS/cm	From data sheet
Dissolved Oxygen	7.7-8.0 mg/L	From data sheet
Feeding	None	
Purity of test substance	99%	
Concentrations measured?	Yes	
Measured is what % of nominal?	113% (range: 103-127%)	
Chemical method documented?	Yes	
Concentration of carrier (if any) in test solutions	1% methanol (10 mL/L)	
Concentration 1 Nom/Meas (μg/L)	0.5/0.59	Reps: 3-5 w/5 per
Concentration 2 Nom/Meas (μg/L)	1.0/1.03	Reps: 3-5 w/5 per
Concentration 3 Nom/Meas (μg/L)	2.5/3.18	Reps: 3-5 w/5 per
Concentration 4 Nom/Meas (μg/L)	5.0/5.27	Reps: 3-5 w/5 per
Control	Dilution water; 1% methanol	Reps: 3-5 w/5 per
LC50; μg/L	1.94	Trimmed Spearman-Karber

Reliability points taken off for:
Documentation: Hardness (2), Alkalinity (2), Photoperiod (3), Minimum significant difference (2 – Test 3 only)
Acceptability: Control response (9 – Tests 2, 3 only), Carrier solvent (4), Organisms randomized (1), Hardness (2), Alkalinity (2), Temperature > +/- 1 ^{o}C (3), Photoperiod (2), Random design (2), Minimum significant difference (1 – Test 3 only)

Salvelinus fontinalis

Toxicity Data Summary

Allison DT, Hermanutz RO. 1977. Toxicity of diazinon to brook trout and fathead minnows. EPA-600/3-77-060. Environmental Research Laboratory-Duluth, Office of Research and Development, US Environmental Protection Agency, Duluth, MN.

Relevance
Score: Acute: 92.5 (Control response NR);
Chronic: 100
Rating: R (both)

Reliability
Score: Acute: 79; Chronic: 89.5
Rating: R (both)

Allison & Hermanutz 1977		
Parameter	**Value**	**Comment**
Test method cited	Acute: APHA Chronic: methods recommended by committee on aquatic bioassays, ERL-Duluth w/ noted exceptions	
Phylum	Chordata	
Class	Actinopterygii	
Order	Salmoniformes	
Family	Salmonidae	
Genus	*Salvelinus*	
Species	*fontinalis*	
Found in	North America	
Age/size at start of test/growth phase	Acute 1: 1 yr Acute 2: 1 yr Acute 3: 1 yr Chronic 1: 1 yr Chronic 2: 1 yr	
Source of organisms	Federal hatchery	
Have organisms been exposed to contaminants?	No	
Animals acclimated and disease-free?	Yes	
Animals randomized?	Yes	
Test vessels randomized?	NR	
Test duration	Acute: 96 h Chronic: 173 d (yearlings) plus 122 d post-hatch (progeny)	
Data for multiple times?	Yes	
Effects	See below	
Control responses	See below	

Allison & Hermanutz 1977		
Parameter	**Value**	**Comment**
Temperature	Acute: 12 $\pm$ 0.5^{o}C Chronic: $\pm$ 1^{o} C from recommended temperature according to date	
Test type	Flow-through	
Photoperiod/light intensity	Acute: NR Chronic: Evansville, IN; variable for life cycle	
Dilution water	Lake Superior	
pH	Acute: within chronic test Chronic 7.3 (7.0-7.6)	
Hardness	Acute: within chronic test Chronic: 45 (42-47) mg/L	
Alkalinity	Acute: within chronic test Chronic: 42 (40-47) mg/L	
Conductivity	Acute: NR Chronic: NR	
Dissolved Oxygen (range)	Acute 1: 65% (43-106) Acute 2: 75% (58-107) Acute 3: 86% (78-95) Chronic adult: 86% (54-103) Chronic larval: 101% (88-109)	
Feeding	Acute: NR Chronic: 2x daily (adults); 5x daily (juveniles, alevins)	
Purity of test substance	92.5%	
Concentrations measured?	Yes	
Measured is what % of nominal? (range)	Acute: NC Chronic: 117% (94-136)	
Chemical method documented?	Yes	
Concentration of carrier (if any) in test solutions	Acute: 24 mg/L (0.03 mL/L) acetone; Chronic: 2 mg/L (0.002mL/L) acetone; Triton-X surfactant at 3% of diazinon concentration in both acute & chronic	Conversion to mL/L based on density of 0.785 g/mL at 25^{o} C
Concentration 1 Acute: Meas (range); mg/L Chronic: Nom/Meas; µg/L	Acute 1: 0.04 (0.04-0.06) Acute 2: 0.03 (0.03-0.04) Acute 3: None Chronic adult: 0.75/0.55 Chronic larval: 0.75/0.80	Reps: Acute: 2 w/20 per Chronic 1 & 2: 2 w/12 per; thinned to 2 males, 4 females

Allison & Hermanutz 1977		
Parameter	**Value**	**Comment**
		at 173 d
Concentration 2 Acute: Meas (range); mg/L Chronic: Nom/Meas; µg/L	Acute 1: 0.08 (0.07-0.1) Acute 2: 0.06 (0.05-0.07) Acute 3: 0.23 (0.20-0.26) Chronic adult: 1.5/1.1 Chronic larval: 1.5/1.4	Reps: Acute: 2 w/20 per Chronic 1 & 2: 2 w/12 per; thinned to 2 males, 4 females at 173 d
Concentration 3 Acute: Meas (range); mg/L Chronic: Nom/Meas; µg/L	Acute 1: 0.16 (0.14-0.18) Acute 2: 0.14 (0.12-0.16) Acute 3: 0.51 (0.46-0.57) Chronic adult: 3.0/2.4 Chronic larval: 3.0/2.7	Reps: Acute: 2 w/20 per Chronic 1 & 2: 2 w/12 per; thinned to 2 males, 4 females at 173 d
Concentration 4 Acute: Meas (range); mg/L Chronic: Nom/Meas; µg/L	Acute 1: 0.39 (0.34-0.47) Acute 2: 0.35 (0.28-0.39) Acute 3: 0.93 (0.88-1.0) Chronic adult: 6.0/4.8 Chronic larval: 6.0/5.6	Reps: Acute: 2 w/20 per Chronic 1 & 2: 2 w/12 per; thinned to 2 males, 4 females at 173 d
Concentration 5 Acute: Meas (range); mg/L Chronic: Nom/Meas; µg/L	Acute 1: 0.92 (0.76-1.2) Acute 2: 0.76 (0.68-0.82) Acute 3: 2.3 (1.9-2.6) Chronic adult: 12.0/9.6 Chronic larval: 12.0/11.1	Reps: Acute: 2 w/20 per Chronic 1 & 2: 2 w/12 per; thinned to 2 males, 4 females at 173 d
Control	Dilution water; solvent	Reps: Acute: 2 w/20 per Chronic 1 & 2: 2 w/12 per; thinned to 2 males, 4 females at 173 d
LC50; µg/L	**Test 1: 800 (440-1140)** **Test 2: 450 (320-630)** **Test 3: 1050 (720-1520)** GeoMean: 767	Litchfield & Wilcoxon
NOEC; µg/L	See below	See below

ACR based on geometric mean LC50 from this test and 167-274-d survival:
LC50/MATC = 767/6.8 = 113

Acute control survival NR, but standard method followed.

NOEC/LOEC (µg/L) determined by ANOVA, Dunnett's; p = 0.05; MSD NR.

Incidence of scoliosis not significant at 91 or 173 d

<u>Survival at 91 d</u>
NOEC = 4.8 (100% of control)
LOEC = 9.6 (92% of control)
MATC = 6.8
Control response: 100%

<u>Average total length at 91 d</u>
NOEC = 9.6 (88.5% of control)
LOEC = > 9.6
MATC = NC
Control response: 252.5 mm

<u>Average weight at 91 d</u>
NOEC = 9.6 (62.7% of control)
LOEC = > 9.6
MATC = NC
Control response: 178.5 g

<u>Instantaneous growth rate at 91 d</u>
NOEC = 2.4 (87% of control)
LOEC = 4.8 (27% of control)
MATC = 3.4
Control response: 44 d^{-1}

<u>Survival at 173 d</u>
NOEC = 4.8 (96% of control)
LOEC = 9.6 (75% of control)
MATC = 6.8
Control response: 100%

<u>Average total length at 173 d</u>
NOEC = 9.6 (83% of control
LOEC = > 9.6
MATC = NC
Control response: 286 mm

<u>Average weight at 173 d</u>
NOEC = 9.6 (55% of control)
LOEC = > 9.6
MATC = NC
Control response: 266 g

<u>Instantaneous growth rate at 173 d</u>
NOEC = 9.6 (68% of control)

LOEC = > 9.6
MATC = NC
Control response: 48.5 d^{-1}

No significant results for number of females spawning, total number of eggs spawned, number of eggs/female, viability of eggs, or gonadal development (males or females).

<u>Progeny average total length at 2 d</u>
NOEC = 5.6 (96% of control)
LOEC = 11.1 (94% of control)
MATC = 7.9
Control response: 15.8 mm

<u>Progeny survival at 30 d</u>
NOEC = 11.1 (100% of control)
LOEC = > 11.1
MATC = NC
Control response: 100%

<u>Progeny average total length at 30 d (interrupted dose response)</u>
NOEC = < 0.80
LOEC = 0.80 (94% of control)
MATC = NC
Control response: 22.5 mm

<u>Progeny instantaneous growth rate at 90 d</u>
NOEC = 5.6 (88% of control)
LOEC = 11.1 (86% of control)
MATC = 7.9
Control response: 126 d^{-1}

<u>Progeny survival at 122 d</u>
NOEC = 11.1 (83% of control)
LOEC = > 11.1
MATC = NC
Control response: 88%

<u>Progeny average total length at 122 d (interrupted dose response)</u>
NOEC = < 0.80
LOEC = 0.80 (85% of control)
MATC = NC
Control response: 65.8 mm

<u>Progeny instantaneous growth rate at 122 d (interrupted dose response)</u>
NOEC = < 0.80
LOEC = 0.80 (90% of control)

MATC = NC
Control response: 155 d^{-1}

Progeny average weight at 122 d (interrupted dose response)
NOEC = < 0.80
LOEC = 0.80 (60% of control)
MATC = NC
Control response: 2.76 g

EPA used a chronic value of < 0.08 based on effects on growth of progeny.

No scoliosis in progeny.

BCF determined in this study:

Adults exposed for 6 months at 4.8 µg/L, based on levels in blood: 13
Adults exposed for 6 months at 1.1 µg/L, based on levels in blood: 17
Mean for blood: 15

Adults exposed for 8 months at 9.6 µg/L, based on levels in muscle: 34
Adults exposed for 8 months at 4.8 µg/L, based on levels in mature male muscle: 24
Adults exposed for 8 months at 4.8 µg/L, based on levels in immature male muscle: 51
Adults exposed for 8 months at 4.8 µg/L, based on levels in spawned female muscle: 19
(mean of above 3 values = 31)
Adults exposed for 8 months at 2.4 µg/L, based on levels in muscle: 35
Adults exposed for 8 months at 1.1 µg/L, based on levels in muscle: 25
Adults exposed for 8 months at 0.55 µg/L, based on levels in muscle: 25
Mean for muscle: 30

Overall mean: 27

Reliability points taken off for:
Documentation: Nominal concentrations (3 – acute only), Conductivity (2), Photoperiod (3 – acute only), Hypothesis tests (8 – acute only), Minimum significant difference (2 – chronic only), Point estimates (8 – chronic only)
Acceptability: Control response (9 – acute only), Measured conc w/in 20% nominal (4 – acute only), Appropriate feeding (3 – acute only), Conductivity (1), Photoperiod (2 – acute only), Adequate replicates (2), Random design (2), Hypothesis tests (3 – acute only), Minimum significant difference (1 – chronic only), Point estimates (3 – chronic only)

Selenastrum capricornutum

Toxicity Data Summary

Study: Hughes JS. 1988. Toxicity of Diazinon Technical to *Selenastrum Capricornutum.* CIBA-GEIGY Lab Sty N. 0267 – 40-1100-1. EPA MRID 40509806.

Chronic data

Relevance
Score: 100 (except NOEC not calculable 85)
Rating: R: EC50, EC25 (L: NOEC)

Reliability
Score: 79
Rating: R

Hughes 1988		
Parameter	**Value**	**Comment**
Test method cited	EPA method	
Phylum	Chlorophyta	
Class	Chlorophyceae	
Order	Sphaeropleales	
Family	Selenastraceae	
Genus	*Selenastrum*	
Species	*capricornutum*	
Family in North America?	Yes	
Age/size at start of test/growth phase	6- 8 day old culture	
Source of organisms	Lab culture	
Have organisms been exposed to contaminants?	No	
Plants acclimated and disease-free?	Yes	
Plants randomized?	NR	
Test vessels randomized?	NR	
Test duration	7 days	
Data for multiple times?	yes	
Effect 1	Mean standing crop, cells/mL	
Control response- Test 1	4,920,000	
Control response – Test 2	6,193,333	
Temperature	24 +/- 2	
Test type	Static	
Photoperiod/light intensity	Constant illumination/4306 lumens/m2	
Dilution water	Deionized, nutrients added	
pH	NR in test, 7.5 medium	
Hardness	NR	nutrient solution recipe included
Alkalinity	NR	"

Hughes 1988		
Parameter	**Value**	**Comment**
Conductivity	NR	"
Dissolved Oxygen	NR	
Feeding	Nutrient medium	
Purity of test substance	87.7%	
Concentrations measured?	Yes	
Measured is what % of nominal?	32-97%	
Chemical method documented?	Yes	
Concentration of carrier (if any) in test solutions	No carrier	
Concentration 1 Nom/Meas (µg/L)	32,000/ 20,600	3 Reps w/ 3000 cells/mL
Concentration 2 Nom/Meas (µg/L)	16,000/ 13,900	"
Concentration 3 Nom/Meas (µg/L)	8,000/ 4,340	"
Concentration 4 Nom/Meas (µg/L)	4,000/ 1830	"
Concentration 5 Nom/Meas (µg/L)	2,000/ 980	"
Concentration 6 Nom/Meas (µg/L)	1,000/ 410	"
Control	(nutrient medium) control	"
Test 2		32- 83% of nom
Concentration 1 Nom/Meas (µg/L)	2,000/ 1,120	
Concentration 2 Nom/Meas (µg/L)	1,000 / 500	
Concentration 3 Nom/Meas (µg/L)	500 / 250	
Concentration 4 Nom/Meas (µg/L)	250/ 120	
Concentration 5 Nom/Meas (µg/L)	125/ 60	
Control	(nutrient medium) control	
EC50; indicate calculation method	6,400	Linear regression
EC25; indicate calculation method	4,250	
NOEC; indicate calculation method, significance level (p-value) and minimum significant difference (MSD)	<60 µg/L	Method: p: MSD:
LOEC; indicate calculation method	410 µg/L	
MATC (GeoMean NOEC,LOEC)	Cannot be determined	
% control at NOEC	Cannot be determined	
% of control LOEC	90%	

Other notes:
In second test 60 ug/L only 10% less than control but statistically different.
All plant/algae data is considered chronic

Reliability points taken off for:

Documentation: Hardness (2), Alkalinity (2), Dissolved oxygen (4), Conductivity (2), pH (3), Statistical significance (2), Minimum significant difference (2), % control at NOEC/LOEC (2)
Acceptability: Measured conc w/in 20% nominal (4), Organisms randomized (1), Hardness (2), Alkalinity (2), Dissolved oxygen (6), Temperature > +/- 1 ^{o}C (3), pH (2), Random design (2), Minimum significant difference (1), NOEC reasonable (1)

Appendix D

Fit test calculations

Raw data and calculations for fit test for diazinon acute data

diazinon LC50s	Omit one 1	2	3	4	5	6	7	8	9	10	11	12	13
0.36	0.52	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36
0.52	1.79	1.79	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52
1.79	4.15	4.15	4.15	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79
4.15	4.30	4.30	4.30	4.30	4.15	4.15	4.15	4.15	4.15	4.15	4.15	4.15	4.15
4.30	10.70	10.70	10.70	10.70	10.70	4.30	4.30	4.30	4.30	4.30	4.30	4.30	4.30
10.70	16.82	16.82	16.82	16.82	16.82	16.82	10.70	10.70	10.70	10.70	10.70	10.70	10.70
16.82	459.6	459.6	459.6	459.6	459.6	459.6	459.6	16.82	16.82	16.82	16.82	16.82	16.82
459.6	723.0	723.0	723.0	723.0	723.0	723.0	723.0	723.0	459.6	459.6	459.6	459.6	459.6
723.0	1643	1643	1643	1643	1643	1643	1643	1643	1643	723.0	723.0	723.0	723.0
1643	3198	3198	3198	3198	3198	3198	3198	3198	3198	3198	1643	1643	1643
3198	4441	4441	4441	4441	4441	4441	4441	4441	4441	4441	4441	3198	3198
4441	7804	7804	7804	7804	7804	7804	7804	7804	7804	7804	7804	7804	4441
7804													

Omitted point, xi:		0.36	0.52	1.79	4.15	4.30	10.70	16.82	460	723	1643	3198	4441	7804
5th percentile	0.36	0.67	0.57	0.40	0.35	0.35	0.32	0.31	0.31	0.31	0.32	0.33	0.33	0.34
F-i(xi)		97.45	95.45	84.64	75.07	74.64	63.33	57.66	23.15	19.87	14.85	11.57	10.19	8.15
		0.9745	0.9545	0.8464	0.7507	0.7464	0.6333	0.5766	0.2315	0.1987	0.1485	0.1157	0.1019	0.0815
1-F(xi)		0.0255	0.0455	0.1536	0.2493	0.2536	0.3667	0.4234						
Min of F-i(xi) or 1-F(xi)		0.0255	0.0455	0.1536	0.2493	0.2536	0.3667	0.4234	0.2315	0.1987	0.1485	0.1157	0.1019	0.0815
pi =2(min)		0.051	0.091	0.3072	0.4986	0.5072	0.7334	0.8468	0.463	0.3974	0.297	0.2314	0.2038	0.163

Raw data and calculations for fit test, continued

		Fisher test statistic	
pi-values	ln(pi-value)	Sum of ln (pi)	X^2_{2n}
0.051	-2.97593	32.35866	0.181527
0.091	-2.3969		
0.3072	-1.18026		
0.4986	-0.69595		
0.5072	-0.67885		
0.7334	-0.31006		
0.8468	-0.16629		
0.463	-0.77003		
0.3974	-0.92281		
0.297	-1.21402		
0.2314	-1.46361		
0.2038	-1.59062		
0.163	-1.81401		

0.18 is > 0.05 so the distribution fits the diazinon acute data set

if X < 0.05 significant lack of fit
***if X > 0.05 fit (no significant lack of fit)